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MSFC CRACK GROWTH ANALYSIS COMPUTER PROGRAM,  
VERSION II (USERS MANUAL)

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16. ABSTRACT  <p>An updated version of the George C. Marshall Space Flight Center Crack Growth Analysis Program is described. The updated computer program has significantly expanded capabilities over the original one. This increased capability includes an extensive expansion of the library of stress intensity factors, plotting capability, increased design iteration capability, and the capability of performing proof test logic analysis.</p> <p>The technical approaches used within the computer program are presented and the input and output formats and options are described. Details of the stress intensity equations, example data, and example problems are presented in the Appendix.</p>			
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## FOREWORD

The computer program described in this manual was developed under Contract Numbers NAS8-31101 and NAS8-31624. These Contracts were monitored by C. Bianca of the George C. Marshall Space Flight Center. K. Roper performed all the computer program coding. The author would like to acknowledge the informative technical discussions held with J. E. Collipriest, Jr., R. M. Ehret, and A. F. Liu during the course of this work.

## INTRODUCTION

In order to include the important consideration of structural failure due to the presence of flaws and crack-like defects in aerospace hardware; it is necessary to have a computer program capable of performing crack growth analysis that is easy to use and generally applicable. The need for a computer program (as opposed to simple hand calculations) arises from the complexity of growth descriptions required for crack growth analysis of real materials in complex structure under a variety of loading and environmental conditions. The MSFC crack growth computer program developed by Del West was designed to meet this need.

The MSFC crack growth computer program calculates crack growth for part through cracks, through the thickness cracks and cracks which are transitioning from part through cracks to through the thickness cracks. The computer program has been written to be flexible in its operation and to be easily adapted and changed as fracture mechanics technology changes and/or the design usage of the program changes.

The computer program is essentially an integration routine which calculates crack growth from an initial defect size and terminates calculation when the crack is sufficiently large for a critical condition (instability or rapid growth) to be reached. The initial defect size may be designated by the user or established

by the computer program on the basis of proof test logic. In addition, if a design life is not met for a particular structure, the program has the capability of varying the thickness of the structure or initial defect size so as to establish the geometry which will meet the design requirements.

During the period when a crack is a part through crack, crack growth in the depth and surface directions may be different due to variations in stress intensity factors and/or directional dependence of material properties. The MSFC computer program considers both of these effects and hence incorporates realistic crack shape changes. During the period when a crack is transitioning from a part through crack to a through the thickness crack, the crack lengths on the backside and the frontside are different. The MSFC computer program tracks the growth of these two dimensions separately; evaluating the stress intensity factors at each surface until these dimensions are the same and the crack has completed its transition to a through the thickness crack.

The computer program allows two different methods of load input. For each step in the loading block, the user specifies either: (1) Maximum Stress, Minimum Stress, Number of Cycles or (2) Maximum Stress, Stress Ratio, Number of Cycles. It should be noted that if crack growth mechanisms other than fatigue are

being considered (e.g., static stress corrosion) the appropriate rate variable can be used instead of cycles (e.g., time at load) in conjunction with appropriate material constants as described below to perform a wide range of phenomenological studies.

The use of a limit load (a load which may be higher than any load in the actual spectrum) to determine the end of design life is a common practice. The MSFC computer program has therefore been written to consider a separate limit load (apart from those in the spectrum) and to determine when it causes failure. However, after failure due to limit load occurs, the crack growth calculation continues. The limit load failure information is included in the output.

The crack growth rate material properties may presently be input into the program in any of four formats: (1) Paris equation with upper and lower outoffs in stress intensity factor; (2) Forman equation with upper and lower cutoffs in stress intensity factor; (3) Collipriest-Ehret equation with additional upper and lower cutoffs in stress intensity factor; (4) tabulated as a function of stress intensity range and stress ratio. An important feature of the material property description is that different material properties (crack growth equations, fracture properties, yield stress, etc.) may be designated for each step in the loading spectrum. Thus varying temperatures and environments may be considered.

The MSFC crack growth computer program has the capability of utilizing any one of three crack growth retardation models. Of course, the effects of retardation on crack growth will not be considered if the user does not request it. The three models presently available are: (1) Willenborg; (2) Wheeler; (3) Grumman Closure Model.

The module which performs stress intensity calculations currently includes stress intensity equations for the following geometries:

- 1) Crack in a finite width finite thickness plate - part through crack, transition crack, through crack.
- 2) ASTM E399 compact specimen - through crack.
- 3) Single crack emanating from a hole - corner crack, internal crack, transition crack, through crack.
- 4) Two cracks emanating from a hole - corner crack, internal crack, transition crack, through crack.
- 5) Single crack emanating from a pin loaded lug - corner crack, internal crack, transition crack, through crack.
- 6) Two cracks emanating from a pin loaded lug - corner crack, internal crack, transition crack, through crack.
- 7) Crack emanating from a notch - corner crack, internal crack, transition crack, through crack.
- 8) Cracks emanating from double notches - corner crack, internal crack, transition crack, through crack.

- 9) Cracks emanating from shoulder radii - corner crack, internal crack, transition crack, through crack.

As many runs (each with varying input conditions) as desired may be stacked. As additional runs are made, only that section of data which is changed (i.e., loads, material properties, or geometry) need be reentered. Output format can include tabulated and/or plotted data. Minimum tabulated output for each run consists of information on input data and failure (crack lengths, cycles, etc.) as well as crack lengths, stress intensity factors, and crack growth rates for the first and last cycle of each stress level in the first load block applied as a part through crack, transitional crack or through crack. Additional information (crack lengths, stress intensity factors, and crack growth rates) for particular blocks and loading steps may be requested by the user. The plotted output consists of plots of surface and crack depth lengths plotted against the number of loading blocks and cycles. The user may specify plotting increments or simply use increments chosen by the computer program.

A flow chart showing all subroutines is presented in Figure 1, and a description of each subroutines primary function is presented in Table I.



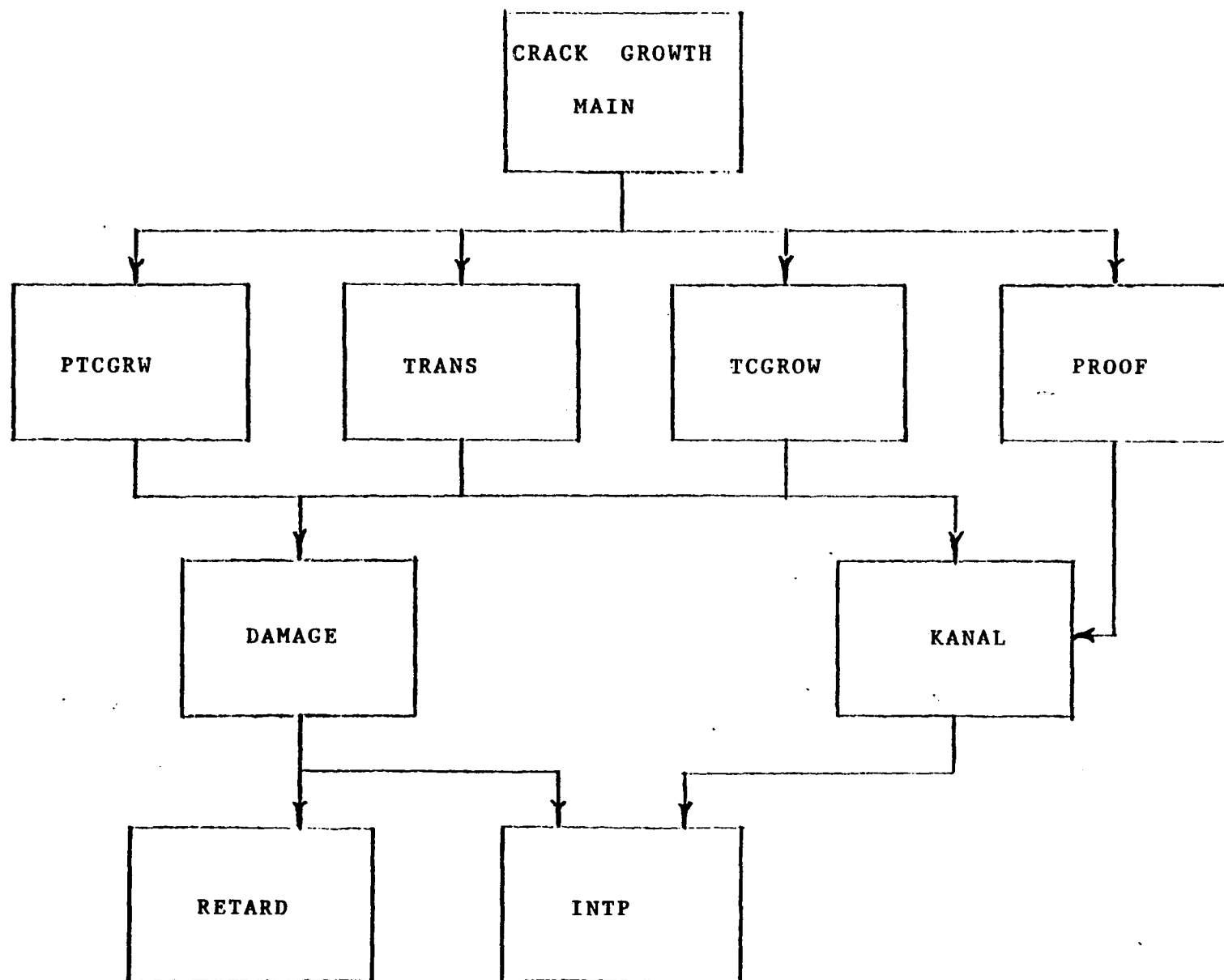


Figure 1 - Subroutines

TABLE I  
SUBROUTINE FUNCTIONS

<u>SUBROUTINE</u>	<u>FUNCTION</u>
MAIN	Reads Input, Sequences Runs, Performs Design Iterations, Calls Proof Test Module, Calls Appropriate Crack Growth Module.
PROOF	Calculates initial flaw size based on proof test logic.
PTCGRW	Calculates crack growth for a part through crack.
TRANS	Calculates crack growth for a transitional crack.
TCGROW	Calculates crack growth for a through crack.
KANAL	Evaluates all stress intensity factors
DAMAGE	Calculates crack growth rates
INTP	Interpolates stress intensity or crack growth rate tables.
RETARD	Modifies input to damage to account for retardation effects.

In addition to the basic crack growth analysis program, a companion program which formats the crack growth data for plotting on the SC4020 plotter is included in the program package. The functional flow of the computer program package is indicated in Figure 2.

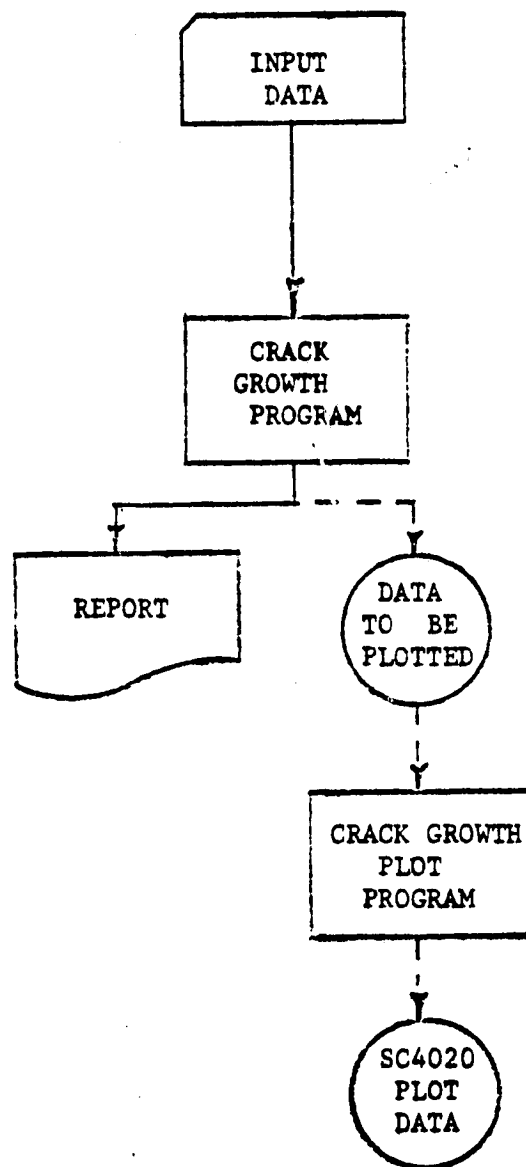


Figure 2 - Functional Flow

### TECHNICAL APPROACH

The essence of the crack growth analysis procedure consists of:

- 1) Establishing an initial defect size: Either directly as input or as a result of proof test logic, or as a result of a design interaction.
- 2) Considering each loading step in a load block in turn.
- 3) Evaluating stress intensity factors, using the stresses from the step under consideration.
- 4) Using these stress intensity factors (and previous loading history if retardation is considered) to calculate crack growth rate.
- 5) Consider a small amount of growth ( 1% of current crack size) and calculate the number of cycles it takes to grow that amount. If that amount exceeds the number of cycles not yet consumed in the step than only those remaining cycles are used and a corresponding crack growth increment is calculated.
- 6) Crack lengths are incremented, cycle count is incremented.
- 7) This process is continued until all cycles in the step are considered. The next step is then called. At the end of a block the first step is called again.
- 8) The calculation ends when:
  - a) The critical stress intensity (either at the surface or at the depth of a crack) is exceeded.
  - b) There is no crack growth ( $<10^{-8}$  in.) for an entire block.
  - c) The crack growth rate goes to infinity (when using the Forman equation for crack growth rate).

- d) The maximum number of blocks is exceeded.
- 9) All input and all output data are in units compatible with Kips and inches. (e.g., Ksi, Ksi  $\sqrt{\text{in.}}$  and in/cycle.)

### SUBROUTINES

The subroutine operations are each described below. Since MAIN serves primarily as a calling routine, it will be clearest if we describe MAIN last.

### PROOF

The proof test module uses an iteration scheme of successive bisections and inverse parabolic interpolation to solve the nonlinear equations that arise in defining the crack size that will cause an applied stress intensity factor due to the proof load to equal the critical stress intensity factor. The critical condition is checked at both the depth and surface of a part through crack. The smallest crack size that produces criticality is the result. The critical stress intensity factors used for the proof test may be different than those used to predict the end of service life.

Thus, changes in environments and their concomitant changes in material properties may be accounted for (e.g., a cryogenic proof test). Either the crack depth (a), the surface length (c) or the shape (a/c) for a part through crack may be kept constant for the proof test calculation.

#### PTCGRW, TRANS, TCGROW

The subroutines PTCGRW, TRANS, and TCGROW calculate the crack growth increments, return to MAIN for information on the next loading step, consider when to end the calculation and transfer to each other (PTCGRW → TRANS → TCGROW) as required. For a part through crack PTCGRW performs these functions until TRANS is called. TRANS is called when the crack depth equals the plate thickness. TRANS performs these functions while the crack is transitioning to a through crack and calls TCGROW when the back surface length exceeds 95% of the front surface length. TCGROW performs these functions when the crack is a through crack and may be called by TRANS or in those cases when a through crack is considered initially it is called from MAIN.

#### KANAL

KANAL is a subroutine which returns factors, which when multiplied by the appropriate loading term yields stress intensity factors. Thus the loading input must be compatible with the crack configuration considered. For the configurations currently in the program

the corresponding name (KTYPO) and required load description are given in Table II. The geometrical arrangement of each configuration is given in Figure 3. Detailed descriptions of the stress intensity factors are given in the Appendix.

### DAMAGE

The subroutine DAMAGE currently contains three equations and a provision for tabulated data for calculating crack growth rate. In all cases the independent variables are the effective stress intensity factor,  $KE$ , and the effective stress ratio,  $RE$ . When retardation is not used  $KE$  is simply the stress intensity range ( $KMAX - KMIN$ ) and  $RE$  is simply the stress ratio. When retardation is used,  $KE$  and  $RE$  are calculated in RETARD.

The following equations all contain material property constants designated by  $D(NC, I, J)$ .  $NC$  indicates whether the surface ( $NC = 1$ ) or depth ( $NC = 2$ ) is being considered.  $I$  distinguishes the various constants in that equation and indicates the order of the constant on the input cards.  $J$  is the material type number which is also input with end loading step. In order to call out the proper equation the corresponding equation name (NEQ) must be specified during input. Note that each material type could use a different NEQ.

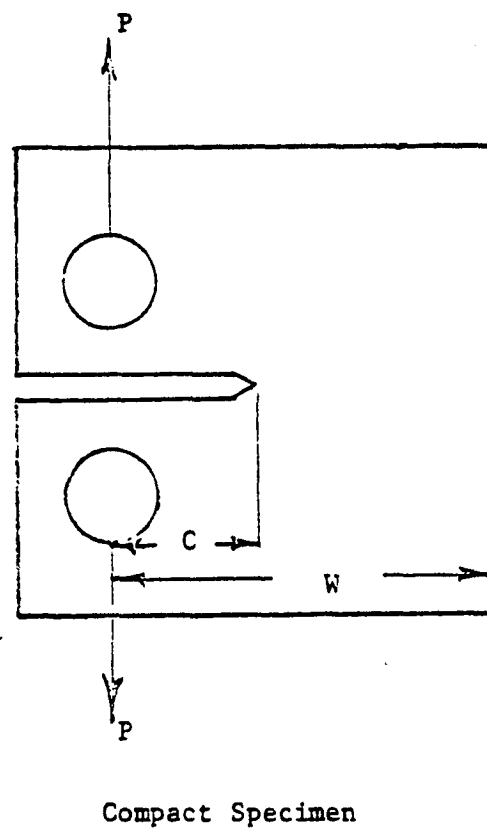
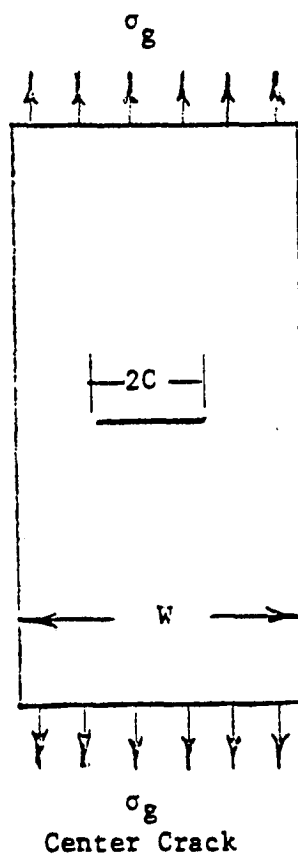


TABLE II - Stress Intensity Factors in Kanal

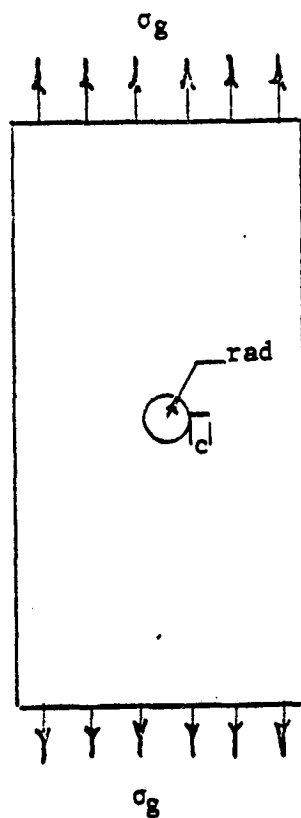
<u>KTYPO(1)</u>	<u>KTYPO(2)</u>	<u>Configuration</u>	<u>Load Description</u>
1	1	PTC - center crack	Gross stress
1	2	None	
1	3	Single corner crack at hole	Gross stress
1	4	Double corner crack at hole	Gross stress
1	5	Single internal crack at hole	Gross stress
1	6	Double internal crack at hole	Gross stress
1	7	General tabular description	As required by tabular description
1	8	Single corner crack pin loaded lug	Pin load
1	9	Double corner crack pin loaded lug	Pin load
1	10	Single internal crack pin loaded lug	Pin load
1	11	Double internal crack pin loaded lug	Pin load
1	12	Corner crack at single notch	Gross stress
1	13	Corner cracks at double notch	Gross stress
1	14	Internal crack at single notch	Gross stress
1	15	Internal cracks at double notches	Gross stress

TABLE II - continued

<u>KTYPO(1)</u>	<u>KTYPO(2)</u>	<u>Configuration</u>	<u>Load Description</u>
1	16	Corner crack at shoulder	Gross stress
1	17	Internal crack at shoulder	Gross stress
2	1-17	Appropriate transition crack corresponding to through crack case - see KTYPO(1)=3 List	As described in corresponding KTYPO(1)=3 List
3	1	Center through Crack	Gross stress
3	2	Compact Specimen (ASTM E399-74)	Pin load
3	3 or 5	Single through crack at hole	Gross stress
3	4 or 6	Double through crack at hole	Gross stress
3	7	General tabular description	As required by tabular description
3	8 or 10	Single through crack - pin loaded lug	Pin load
3	9 or 11	Double through crack pin loaded lug	Pin load
3	12 or 14	Through crack at single notch	Gross stress
3	13 or 15	Through cracks at double notches	Gross stress
3	16 or 17	Through cracks at shoulder	Gross stress



Single Crack at Hole



Double Crack at Hole

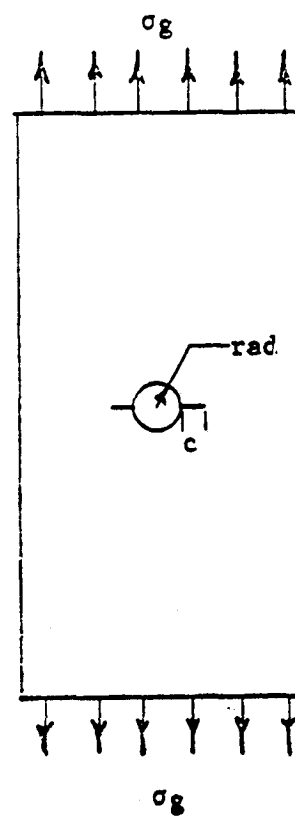
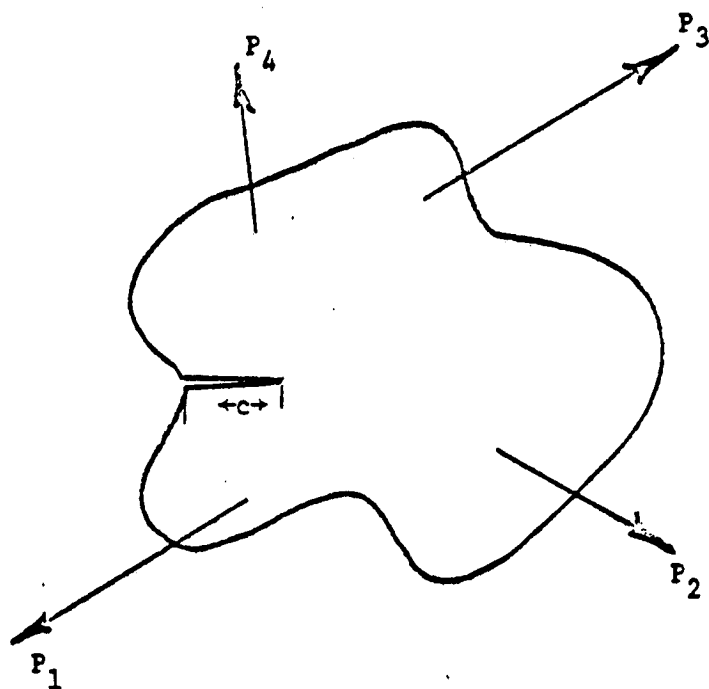


Figure 3(a) - Configuration Planforms



General Tabular Description

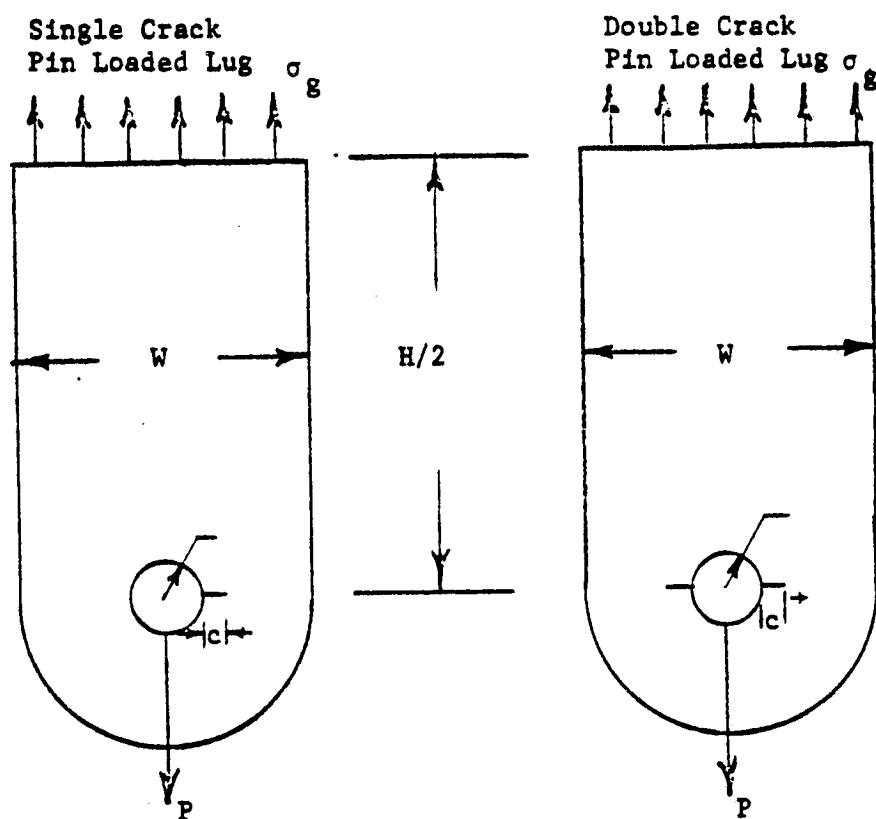


Figure 3(a) Cont.

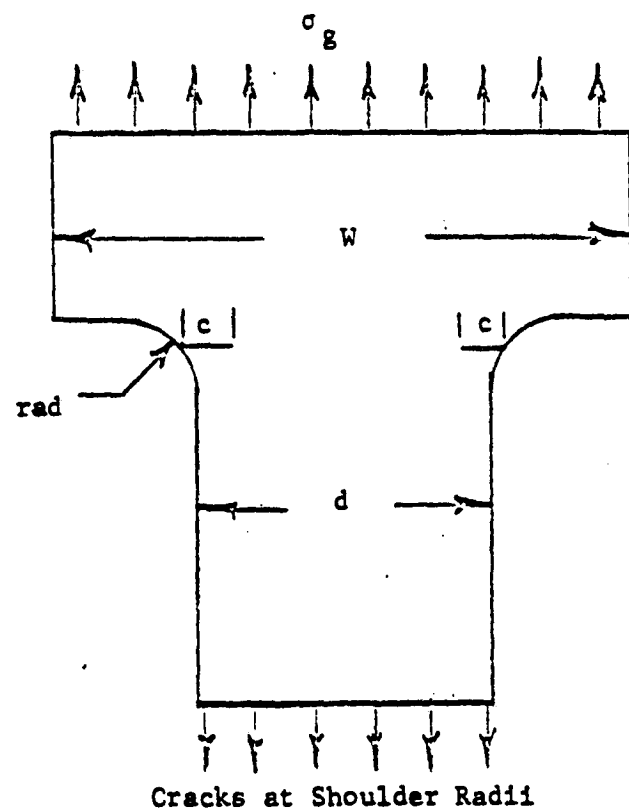
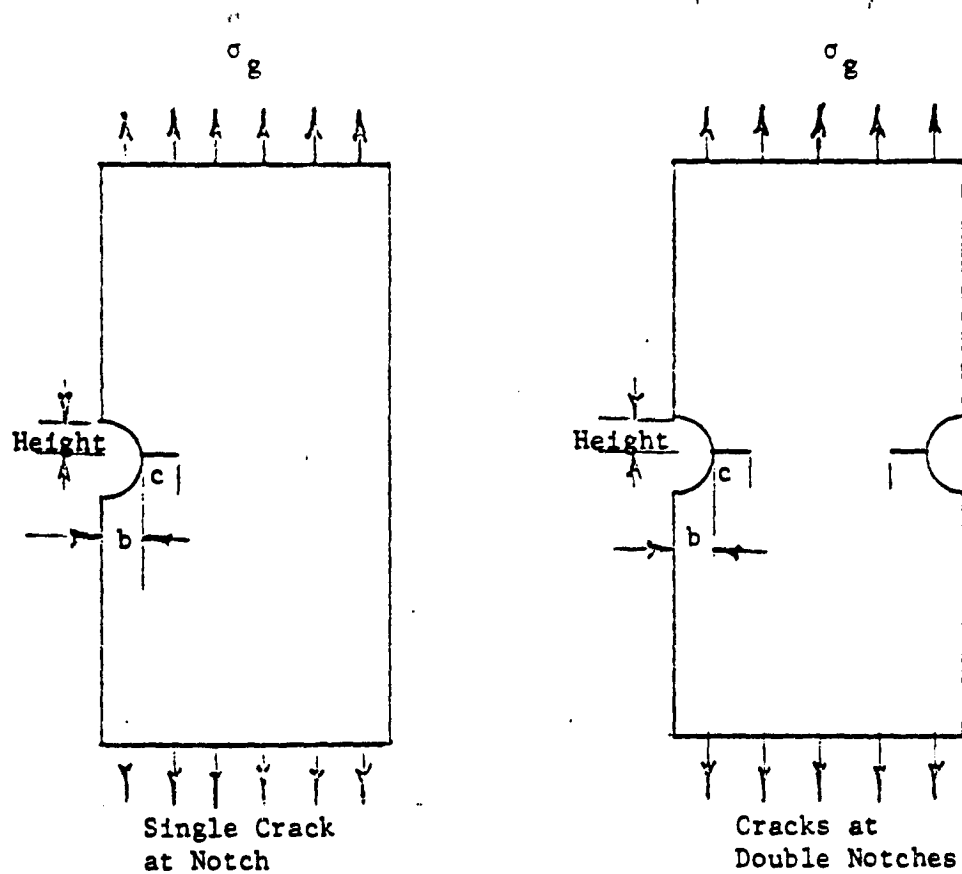


Figure 3(a) Cont.

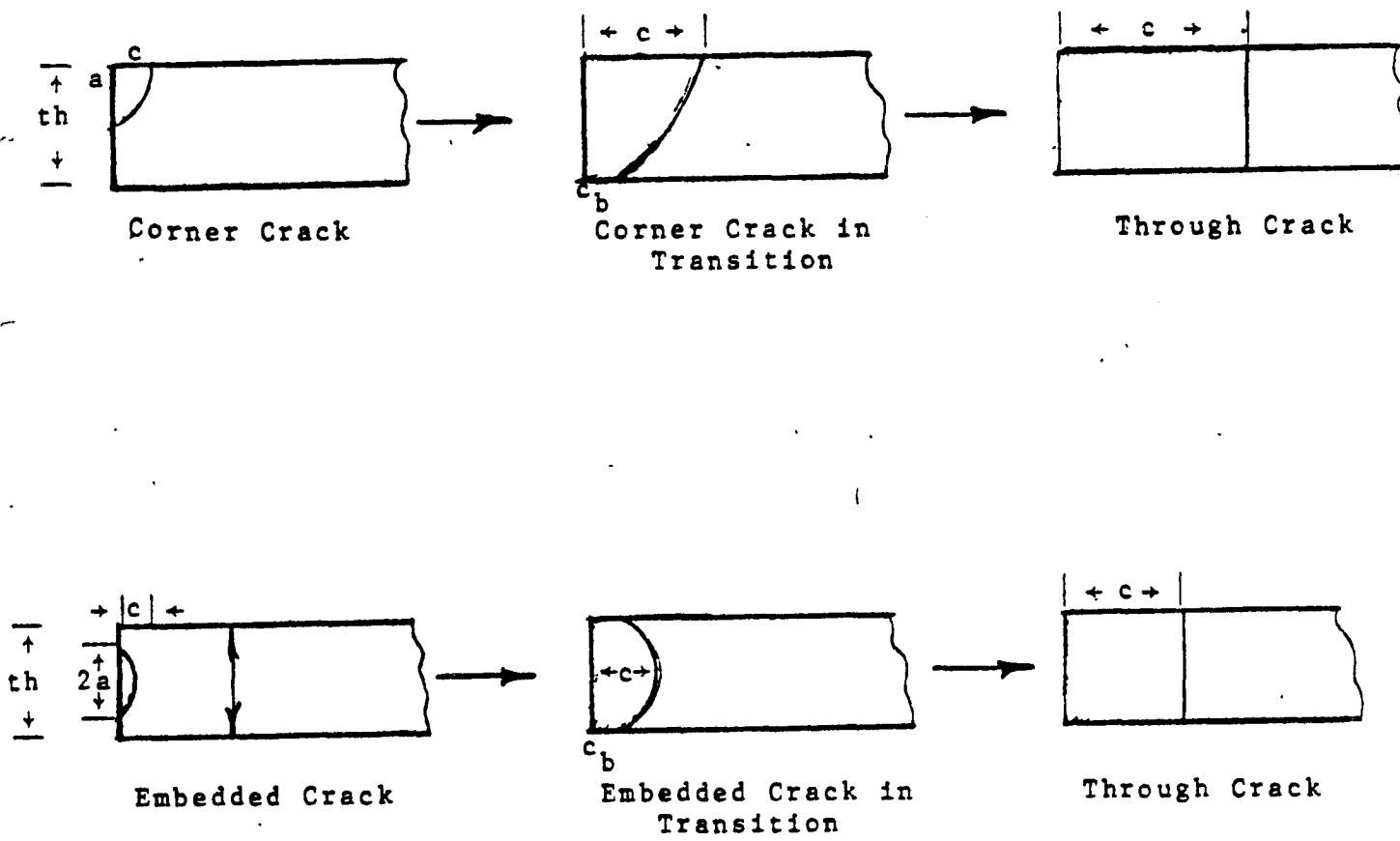


Figure 3b - Configuration Crossections

NEQ	EQUATION
1	Collipriest-Ehret
2	Paris
3	Forman
4	Tabulated Data

The use of "J" allows various loading steps to use different crack growth rate equations and thus variations in environment and crack growth phenomenon (fatigue or stress corrosion) can be accounted for.

The Collipriest-Ehret equation is:

$$\frac{da}{dn} = C_1 \exp \left[ C_2 \tanh^{-1} \left( \frac{\ln(K E^2 / (1-RE) D(NC,3,J) D(NC,4,J))}{\ln(1-RE) D(NC,3,J) / D(NC,4,J)} \right) \right]$$

$$C_2 = \ln \left( \frac{D(NC,3,J)}{D(NC,4,J)} \right)^{\frac{D(NC,2,J)}{2}}$$

$$C_1 = D(NC,1,J) \left[ D(NC,3,J) D(NC,4,J) \right]^{\frac{D(NC,2,J)}{2}}$$

where

$D(NC,1,J)$	Crack growth rate coefficient
$D(NC,2,J)$	Dimensionless coefficient relating to midrange slope.
$D(NC,3,J)$	Critical stress intensity (upper asymptote)
$D(NC,4,J)$	Threshold stress intensity range (lower asymptote)

The Paris equation is:

$$\frac{da}{dn} = D(NC,1,J) K E^{D(NC,2,J)}$$

The Forman equation is:

$$\frac{da}{dn} = \frac{D(NC,1,J) K E^{D(NC,2,J)}}{(1-RE) D(NC,3,J) - KE}$$

where

D(NC,1,J)	Crack growth rate coefficient
D(NC,2,J)	Crack growth rate exponent
D(NC,3,J)	Critical stress intensity (upper asymptote)

Tabulated data is in input as a function of stress intensity range and stress ratio. If retardation is to be used, the variables are effective stress intensity range and effective stress ratio. The computer program performs linear interpolation in stress ratio and logarithmic interpolation in stress intensity range. This results in a "Paris Equation" fit between consecutive data points at a constant stress ratio. All stress ratios between the highest given in the Table and 1.0 use the crack growth rate at the highest stress ratio data supplied. The lowest stress ratio required by the loading spectrum must be within the range of the input data.

The format for crack growth data input is shown in Figure 4. For this mode of crack growth description only three material



types may be used. Thus, there is the possibility of supplying 6 Tables (surface/depth direction for each material type)

	RE(NT,1)	RE(NT,2)	.	.	.	.	RE(NT,m)
KE(NT,1)	<div style="border: 1px solid black; padding: 10px; display: inline-block;"> <math>\frac{da}{dn}(NT,1,J)</math> <math>\frac{da}{dn}(NT,1,m)</math> </div>						
KE(NT,2)							
.							
.							
.							
KE(NT,l)							$\frac{da}{dn}(NT,l,m)$

$$l \leq 25, m \leq 25$$

NT goes from 1 to 6 and is set automatically by the computer program and takes on values according to the following Table:

TABLE III

<u>Material Type</u>	<u>Growth Direction</u>	<u>NT</u>
1	Surface	1
1	Depth	2
2	Surface	3
2	Depth	4
3	Surface	5
3	Depth	6

### RETARD

The subroutine RETARD currently contains three retardation models. In each of these a crack tip plastic zone  $r_y$  is calculated according to the equation

$$r_y = \frac{1}{(2\pi)P_z} \times \frac{K_{\max}^2}{\sigma_{ys}^2}$$

where  $P_z$  is a constant depending on the degree of plane stress versus plane strain. For plane stress  $P_z = 1$ . For plane strain  $P_z = 3$ .

The following is the retardation equation number for each retardation model.

#### NRET

1	Willenborg Model (Ref. 1)
2	Wheeler Model (Ref. 2)
3	Grumman Closure Model (Ref. 3)

The Willenborg retardation model calls for no constants other than  $P_z$ . The only material property input for this model is therefore

$$CR(NC,1,J) = P_z$$

The "Wheeler" model in this computer program is actually a variation of the model originally presented by Wheeler. Wheeler used a modification to the crack growth rate to produce a retardation effect and we have used a modification to the dependent

variable KE. If the Paris equation is used for crack growth rate the "Wheeler" model in this computer program is identical to the model presented in Ref. . The input material properties for this model are

$$CR(NC,1,J) = P_z$$

$$CR(NC,2,J) = m/n$$

where  $m$  is identical to the " $m$ " used in Ref. and  $n$  is the exponent in the Paris equation (i.e., if the "Wheeler  $m$ " were 5 and the Paris " $n$ " 4, the input value for  $CR(NC,2,J)$  is 1.25).

The details of the Grumman Closure model are too complex to be described here. The input is described below

<u>Input Quantity</u>	<u>Name in Reference 3</u>
CR(NC,1,J)	$P_z$
CR(NC,2,J)	$C_f^{-1}$
CR(NC,3,J)	$C_{f_0}$
CR(NC,4,J)	$P$
CR(NC,5,J)	NSAT
CR(NC,6,J)	$v_1$
CR(NC,7,J)	$B$

### INTP

INTP is a subroutine which interpolates tabular data. It is called from either KANAL or DAMAGE. When called from KANAL it will use the appropriate input Table and linearly inter-

polate in both (a) and (c) for part through cracks and linearly in (c) for through and transition cracks to obtain values of stress intensity factors. When called from DAMAGE it will use the appropriate input Table and interpolate linearly in stress ratio and logarithmically in stress intensity to obtain crack growth rates.

#### MAIN

MAIN reads all input data; controls calling sequences of subroutines PROOF, PTCGRW, TRANS and TCGROW; performs iterations on thickness or initial crack size to obtain desired crack growth lives; and controls output.

## INPUT

There are 27 distinct data input card formats. These are described below and illustrated on pages 36 and 37. Pages 38 and 39 show when each card type is required. The superscript x designates fixed point numbers. All others are floating point.

CARD TYPE	FIELD	NOMENCLATURE	DESCRIPTION
1	1-80	TITLE	Any alphanumeric description of group of runs.
2	1-4	NRUNS <sup>x</sup>	Total number of runs (one run corresponds to a unique set of input data.)
2	5-10	NBLOCK <sup>x</sup>	Maximum number of blocks to be considered. Crack growth calculation ceases when the number of blocks exceeds this number.
2	11-14	MBLOCK <sup>x</sup>	Block interval for which additional data will be printed (e.g., 3 would imply that blocks 3,6,9,12....etc. would have data printed out).
2	15-18	MSTEP <sup>x</sup>	Step interval for which additional data will be printed (in the blocks called out above).
3	1-10	CSTRS	Constant multiplier for stress inputs. Allows stress spectrum to be varied by changing one number only. (e.g., one run with this constant 1.1, will show the effect of varying the stress 10%).
3	11-14	NSUP <sup>x</sup>	Constant for suppression of retardation in crack growth analysis. If zero, retardation is not considered. If retardation is to be considered, constant must be 1.

CARD TYPE	FIELD	NOMENCLATURE	DESCRIPTION
3	15-18	NLOAD <sup>x</sup>	Constant to indicate whether new load data is to be input. If zero, (or any number not equal to 1) load data will not be read in and load data from previous run will be used. If it is 1, card types 4 and 5 must follow.
3	19-22	NGEOM <sup>x</sup>	Constant to indicate whether new geometry data is to be input. If zero (or any number other than 1) geometry data will not be read in and geometry data from previous run will be used. If it is 1, card types 6 and 7 must be read in.
3	23-26	NMAT <sup>x</sup>	Constant to indicate whether new material data is to be input. If zero (or any number other than 1) material data will not be read in and material data from previous run will be used. If it is 1, card types 8, 9, 10, and 11, 12, 13, if needed must be read in.
3	27-30	ITERTP <sup>x</sup>	Parameter that identifies variables for iteration to find geometry that survives the desired life. If ITERTP = 1, the thickness is varied. If ITERTP = 2, the surface crack length is varied and the crack depth (if a part through crack) is kept constant. If ITERTP = 3, the crack depth is varied and the surface length is kept constant. If ITERTP = 4, the crack shape is kept constant and both the crack depth and surface length are varied. Field may be left blank if ITER is zero (or blank).
3	31-34	ITER <sup>x</sup>	Maximum number of iterations to find thickness or crack size that produces the desired life. May not exceed 10, may be left blank. Next two items on card three may be left blank, if ITER equals zero (or blank).

CARD TYPE	FIELD	NOMENCLATURE	DESCRIPTION
3	35-44	PIT	Parameter to control rate of convergence on design iteration. Usually set to exponential power in Paris crack growth equation for crack growth data. When other crack growth equation is used, approximate value of a "Paris exponent" will be sufficient. Must always be greater than 1.
3	45-54	BLIFE	Desired life in blocks.
3	55-58	NPROOF <sup>x</sup>	Parameter that identifies variables in proof test logic. If zero (or blank) no proof test logic is performed. If 1, the crack surface and depth of a part through crack is varied and the shape held constant; if 2 the surface crack length of a through crack is varied; if 3 the crack depth of a part through crack is varied and the surface crack length is held constant; if 4 the surface crack length is varied and the depth is held constant.
3	59-62	IPL0T <sup>x</sup>	Parameter to indicate whether output is to be plotted. If zero (or blank) data is not plotted. Any other value produces a plot of crack lengths versus blocks and cycles.
3	63-72	PCYC(1)	Interval in cycles between plotted data points. If zero, plotted points will correspond to tabular output.
4	1-4	NSTEP <sup>x</sup>	Number of steps in load blocks.
4	5-8	IR <sup>x</sup>	Zero if input format includes minimum stress, 1 if input format includes stress ratio.

CARD TYPE	FIELD	NOMENCLATURE	DESCRIPTION
4	9-18	SIGLM	Limit stress for additional end of life determination. Failure due to limit load does not terminate crack growth calculation.
5	1-10	SMAX	Maximum stress.
5	11-20	SMIN	Minimum stress if IR = 0, stress ratio of IR = 1.
5	21-30	UNIT	Number of cycles or alternate rate variable.
5	31-34	TYPE <sup>x</sup>	Material property data type to be used.
6	1-4	KTYPO(1) <sup>x</sup>	Initial crack type; 1 corresponds to a part through crack; 2 corresponds to a transition crack and 3 corresponds to a through crack.
6	5-8	KTYPO(2) <sup>x</sup>	Parameter which specifies geometry (e.g., corner crack at hole) See page 17 for geometry descriptions.
7	1-10	W	Plate width.
7	11-20	TH	Plate thickness
7	21-30	CO	Initial half surface length for part through crack or through crack. Corresponds to initial value of "C" in Figure 3.
7	30-40	AO	Initial crack depth for a part through crack. May be left zero for through cracks.
7	41-50	H	Configuration dimension as described on pages 17 through 19.



CARD TYPE	FIELD	NOMENCLATURE	DESCRIPTION
7	51-60	RAD	Hole or notch radius or notch height as described on pages 17 through 19.
Cards 8-14 are only used when KTYPO(2) is set equal to 7.			
8	1-4	NKTMX <sup>x</sup>	Number of sets of stress intensity tables. For PTC there are 2 tables per set. The first table of each set is for surface stress intensity factors. The second table is for the stress intensity at the depth. See Appendix for a description of the tables. For through cracks there is one table per set. Three is the maximum number of sets allowed.
9	1-10	C1(NT,I)	Values of surface crack length for table NT surface stress intensity factor. Maximum number of values is 25.
	78-80		If letters "END" appear in this field the value in field 1-10 is the last entry in the list.
10	1-10	A1(NT,J)	Values of crack depth for table NT of surface stress intensity factor. Maximum number of values is 25. These are not read in if crack is a through crack.
	78-80		If letters "END" appear in this field the value in field 1-10 is the last entry in the list.
11	1-10 11-20 etc.	F1(NT,I,J)	Table of surface stress intensity factor coefficients at above crack lengths. Each series of cards is for a constant value of surface crack length (e.g., if the configuration is a through crack each card will contain one table value).
12	1-10	C2(NT,I)	Values of surface crack length for table NT depth stress intensity factor. Maximum number of values is 25.
	78-80		If letters "END" appear in this field the value in field 1-10 is the last entry in the list.

CARD TYPE	FIELD	NOMENCLATURE	DESCRIPTION
13	1-10  78-80	A2(NT,J)	Values of crack depth for table NT of depth stress intensity factor. Maximum number of values is 25. These are not read in if crack is a through crack. If letters "END" appear in this field the value in field 1-10 is the last entry in the list.
14	1-10 11-20 etc.	F2(NT,I,J)	Table of depth stress intensity factor coefficients at above crack lengths. Each series of cards is for a constant value of depth crack length (e.g., if the configuration is a through crack each card will contain one table value).
15	1-4	NJ <sup>x</sup>	Number of material property types.
16	1-10	SIGYS	Yield stress.
16	11-14	NEQ <sup>x</sup>	Equation to be used for crack growth. 1 = Collipriest-Ehret, 2 = Paris, 3 = Forman, 4 = table.
16	15-18	NRET	Model to be used for retardation 0 = none, 1 = Willenborg, 2 = Wheeler, 3 = Grumman Closure (not debugged).
16	19-22	NDUP <sup>x</sup>	Constant to indicate whether crack growth properties are the same in depth and surface directions. If constant = 1, they are not and two sets of D's and CR's (see cards 20, 21, 22, 24, and 26) must be input.
16	23-32	KCRC	Critical stress intensity in surface direction (upper cutoff).
16	33-42	KOC	Threshold stress intensity in surface direction (lower cutoff).
16	43-52	KCRA	Critical stress intensity in depth direction. Need not be input if crack is a through crack.

CARD TYPE	FIELD	NOMENCLATURE	DESCRIPTION
16	53-62	KOA	Threshold stress intensity in depth direction. Need not be input if crack is a through crack
Cards 17 - 22 only used when NEQ = 4			
17	1-10  78-80	KE(NT,I)	Values of stress intensity factor range for table of crack growth rates. Maximum number is 25. If letters "END" appear in this field, value in field 1-10 is last entry in list.
18	1-10  78-80	RE(NT,J)	Values of stress ratios for crack growth rate table. At least one is required. Maximum number is 25. If letters "END" appear in this field, value in field 1-10 is last entry in list.
19	1-10 11-20 etc.	DCDN(NT,I,J)	Values of surface crack growth rate corresponding to above stress intensity values and stress ratios. Each series of cards is for a constant value of stress intensity range (e.g., if 4 values of RE were to be used, each card type 15 would have 4 entries).
20	1-10  78-80	KE(NT,I)	Values of stress intensity factor range for table of crack growth rates. Maximum number is 25. If letters "END" appear in this field, value in field 1-10 is last entry in list.
21	1-10  78-80	RE(NT,J)	Values of stress ratios for crack growth rate table. At least one is required. Maximum number is 25. If letters "END" appear in this field, value in field 1-10 is last entry in list.

CARD TYPE	FIELD	NOMENCLATURE	DESCRIPTION
22	1-10 11-20 etc.	DADN(NT,I,J)	Values of depth crack growth rate corresponding to above stress intensity values and stress ratios. Each series of cards is for a constant value of stress intensity range (e.g., if 4 values of RE were to be used, each card type 15 would have 4 entries).
23	1-10  78-80	D(1,I,J)	Constants in crack growth equations-surface direction. See text for description of constants. If letters "END" appear in this field, value in field 1-10 is last entry in list.
24	1-10  78-80	D(2,I,J)	Constants in crack growth equation-depth direction. If NDUP ≠ 1, card is not used. See text for description of constants. If letters "END" appear in this field, value in field 1-10 is last entry in list.
25	1-10  78-80	CR(1,I,J)	Constants in retardation equation-surface direction. See text for description of constants. If letters "END" appear in this field, value in field 1-10 is last entry in list.
26	1-10  78-80	CR(2,I,J)	Constants in retardation equation-depth direction. If NDUP ≠ 1, card is not used. See text for description of constants. If letters "END" appear in this field, value in field 1-10 is last entry in list.
Card 27 is not used if NPROOF = 0			
27	1-10	FIXED	Value of quantity which remains constant during proof test evaluation.
27	11-20	KCPRF	Value of critical surface stress intensity factor for proof test.

CARD TYPE	FIELD	NOMENCLATURE	DESCRIPTION
27	21-30	KAPRF	Value of critical stress intensity at depth for proof test.
27	31-40	XLOW	Lower bound on variable in proof test (smallest expected value on crack size or shape).
27	41-50	XUP	Upper bound on variable in proof test (largest expected value on crack size or shape).
27	51-60	PROOFX	Proof stress (or load).
27	61-70	IEND	Number of iterations to find crack size in proof test. If zero or blank, default condition sets number of iterations to 100.

All Numeric Fields are in either E10.0, I4 or I6 Formats

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

TITLE

NRUNS NBLOCK MBLOCK MSTEP

CSTRS

NSUP

NLOAD

NGEDM

NPAT

ITERTP

ITER

PIT

BLIFE

NPROOF

IPLDT

PCIC(1)

NSTEP

IR

SIGLM

SMAK

SMIN

UNIT

TYPE

KTYPE0(1) KTYPE0(2)

W

TH

CO

AO

H

RAD

EXTIME

C1(NT,I)

last type 9 card only + E N D

A1(NT,J)

last type 10 card only + E N D

F1(NT,I,J)

F1(NT,I,J)

C2(NT,I)

last type 12 card only + E N D

A2(NT,J)

last type 13 card only + E N D

Card Type

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**All Numeric Fields are in either E10.0, 14 or 16 Formats**

-Card Type

CARD TYPE	FIELD	WHEN INPUT DATA REQUIRED
1	1-80	Once for each session
2	1-16	Once for each session.
3	1-26	Once for each run.
3	27-54	Whenever an iteration on thickness to meet design life is desired.
3	55-58	Whenever proof test logic is used.
3	59-72	Whenever plotted output is required.
4	1-18	Whenever NLOAD = 1.
5	1-34	NSTEP times when NLOAD = 1.
6	1-8	Whenever NGEOM = 1.
7	1-60	Whenever NGEOM = 1.
8	1-4	Whenever KTYPO(2) = 7.
9	1-10	*Whenever KTYPO(2) = 7.
10	1-10	*Whenever KTYPO(2) = 7 and KTYPO(1) = 1.
11	1-80	*Whenever KTYPO(2) = 7
12	1-10	*Whenever KTYPO(2) = 7 and KTYPO(1) = 1.
13	1-10	*Whenever KTYPO(2) = 7 and KTYPO(1) = 1.
14	1-80	*Whenever KTYPO(2) = 7 and KTYPO(1) = 1.
15	1-4	Whenever NMAT = 1.

NKTMX Times



CARD TYPE	FIELD	WHEN INPUT DATA REQUIRED	
16	1-62	*Whenever NMAT = 1.	NJ Times
17	1-10	*Whenever NEQ = 4.	
18	1-10	*Whenever NEQ = 4.	
19	1-80	*Whenever NEQ = 4.	
20	1-10	*Whenever NEQ = 4 and NDUP = 1.	
21	1-10	*Whenever NEQ = 4 and NDUP = 1.	
22	1-8	*Whenever NEQ = 4 and NDUP = 1.	
23	1-10	*Whenever NEQ ≠ 4 and NMAT = 1.	
24	1-10	*Whenever NEQ ≠ 4 and NDUP = 1 and NMAT = 1.	
25	1-10	*Whenever NEQ ≠ 4 and NMAT = 1 and NRET ≠ 0.	
26	1-10	*Whenever NEQ ≠ 4 and NMAT = 1 and NRET ≠ 0.	
27	1-70	Whenever NPROOF ≠ 0	

\* Indicates card types that may be repeated.

### CONTROL OF OUTPUT

In addition to information describing the input data and final fracture, the computer program output consists of crack lengths, stress intensity factors, crack growth rates and cycle counts. These are printed out for the first and last cycle in the step. This data is always printed for each step of the first block encountered in any of the growth modules (PTCGRW, TRANS or TCGROW). This data may also be printed out for additional blocks and steps as desired by the user. These additional blocks and steps are controlled by specifying the increment for blocks and steps for which print out will be made by MBLOCK and MSTEP respectively. Thus, if every step in every other block is wanted, MBLOCK is set equal to 2 and MSTEP is set equal to 1.

Plotted output is supplied when IPLOT is a value not equal to one. Typical plotted output is presented in the Appendix. The spacing of each data point in the plot is set by the user through PCYC(1). PCYC(1) is the increment in cycles between successive data points. If PCYC(1) is zero, the plotted data points will correspond to the tabulated data points as described above. Sample output is shown in Figure 4.

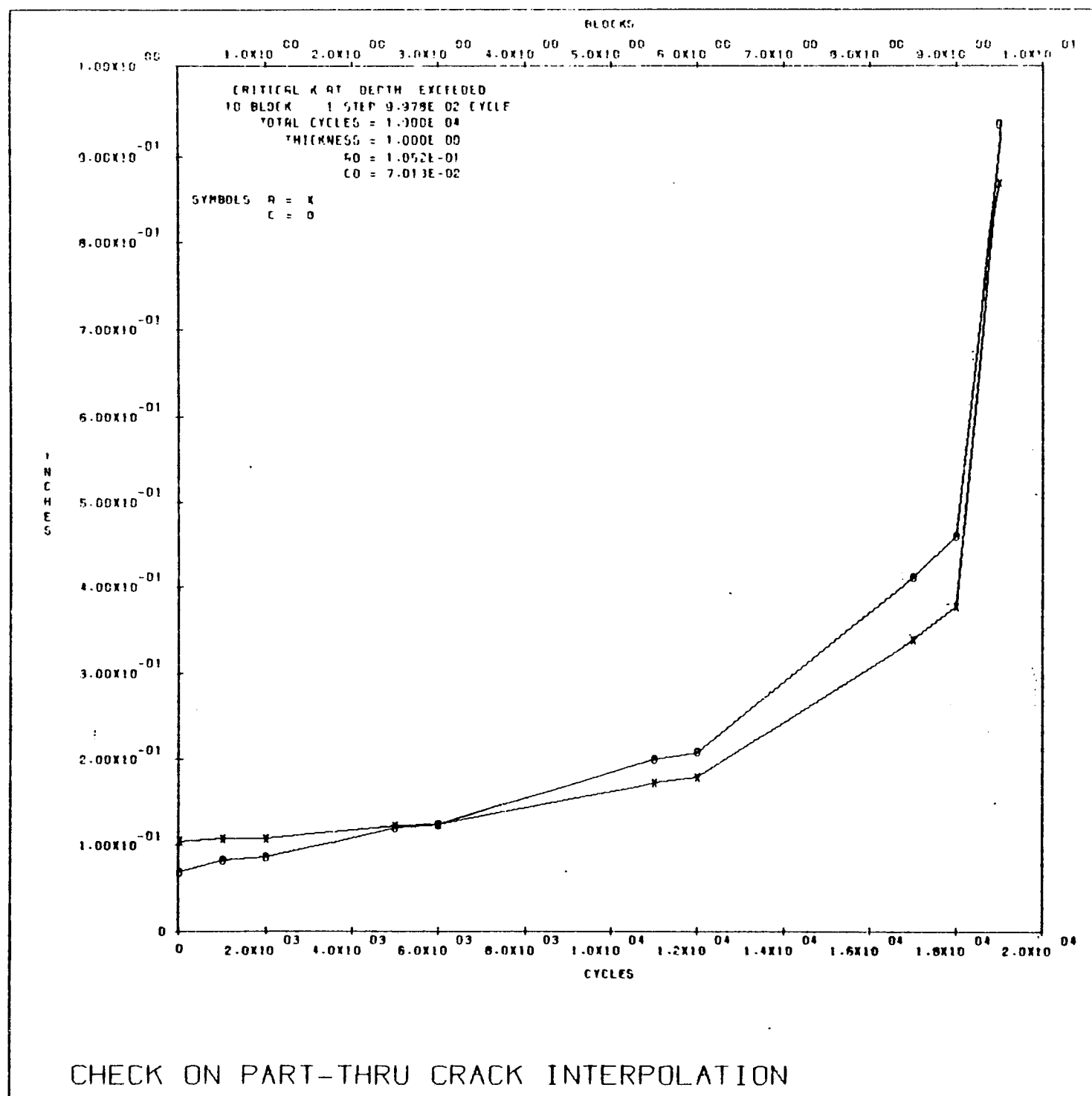


Figure 4 - Sample Plotted Output

### INPUT FOR ADDITIONAL RUNS

A full set of input data is not necessary for each additional run. The use of a stress multiplier constant (CSTRS) allows all the stress to be varied by a constant percentage without inputting any additional input cards other than card type 3. If the stresses are to be used directly as they are on card type 5, CSTRS is input as 1.

The input constant NSUP allows retardation to be suppressed on subsequent runs. That is if a run is made that considers retardation, the following run will perform the same analysis without retardation if NSUP = 0. When retardation is considered NSUP must be set equal to 1. Obviously the order of running the cases must be retarded, followed by unretarded.

In order to control whether loading data, geometry data, or material properties are to be read in for a particular run, the constants NLOAD, NGEOM, NMAT must be input. If data is to be read in, the appropriate constant must be 1, if it is not to be read in, the appropriate constant is 0. If data is not read in, data from the previous run is used. Obviously, for the first run NLOAD, NGEOM AND NMAT must all be 1.

### ITERATION ON THICKNESS AND INITIAL CRACK SIZE

For a given design life (in blocks) the computer program will search for the thickness or initial crack size which will meet that life requirement. The number of iterations attempted is input by the user. The maximum that this may be is ten. This computer program ceases its search when the allowed number of iterations is exceeded or the computed life lies between 100% and 105% of the design life. Life is arbitrarily defined as the number of blocks completed plus the number of steps completed / total number of steps + cycles completed in the current step / total number of cycles in the step.

In addition to inputting the number of iterations and the design life, an exponent which will control the rate of convergence to the correct thickness or initial crack size must be inserted. When the Paris equation is used with zero threshold for a through the thickness crack, the use of the exponent of the Paris equation for the convergence parameter should result in a convergence to the correct solution in a single cycle. Any constant equal to or greater than the "Paris coefficient" should insure convergence.

### PROOF TEST LOGIC

For given values of the fracture toughness and applied proof test load, the computer program will find the largest crack size that will not fail due to the proof load. Since the applied stress intensity factor for a part through crack depends on two geometric variables, the crack depth and surface crack length; one variable must be fixed by the user and the computer program will find the critical value for the other variable. Either the crack depth, surface crack length or crack shape ( $a/c$ ) may be fixed.

#### REFERENCES

- 1) Willenborg, R. M., Engle, R. M., and Wood, H. A.,  
"A Crack Growth Retardation Model Using an Effective  
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- 2) Wheeler, D. E., "Crack Growth Under Spectrum Loading,"  
General Dynamics, Fort Worth Division, FZM 5602  
June, 1970.
- 3) Bell, P. D., and Creager, M. "Crack Growth Analysis  
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Vol. 1, Final Report: June, 1972 - Oct., 1974.

APPENDIXES



### CRACK GROWTH RATE DATA

The following data for use in the Collipriest/Ehret equation (NEQ = 1) is typical data for the materials listed. The data is included for example purposes only and caution is advised with regard to design implications of the data presented. The crack growth rate is in in/cycle and the stress intensity factor is in Ksi  $\sqrt{\text{in.}}$

Material	D(NC,1,J) Coefficient	D(NC,2,J) Relates to Midrange Slope	D(NC,3,J) Upper Asymptote	D(NC,4,J) Lower Asymptote
2024-T851	$1.6 \times 10^{-9}$	3.45	38.0	3.4
2124-T851	$3.3 \times 10^{-10}$	4.0	31.0	3.5
2219-T87 (70°F)	$2.2 \times 10^{-9}$	3.3	40.0	5.5
2219-T87 (-320°F)	$8.9 \times 10^{-12}$	4.82	50.0	5.5
7075-T6	$4.4 \times 10^{-8}$	2.53	33.0	3.0
7075-T76	$6.3 \times 10^{-9}$	3.0	30.0	3.0
7075-T73	$1.07 \times 10^{-8}$	2.67	40.0	3.5
Ti-6Al-4VSTA	$6.8 \times 10^{-10}$	3.3	50.0	7.0
Ti-6AL-4V Annealed	$5.7 \times 10^{-10}$	3.18	84.0	6.0
Inconel 718 (STA)	$4.0 \times 10^{-10}$	2.7	115.0	15.0
D6AC	$7.5 \times 10^{-10}$	2.74	90.0	6.0

APPENDIX B  
CRACK GROWTH ANALYSIS EXAMPLES

A series of five computer sessions are presented below. The flexibility and generality of the MSFC crack growth program make it impractical to present all possible variations here. However, the following examples which include many multiple run sessions cover a broad spectrum of the program's capability.

In addition to showing the card images for each example input, we have included the card type represented by each line in the input data.

Example 1 - 2219 Al 70 deg and -320 deg part-thru and center crack.

Sample input data for a series of two runs is given on page B-6. The first run is a part through crack subjected to a series of two loads of 1000 cycles each. The material properties associated with each load level are different so as to model the effect of temperature variations. The second run is the same except that the initial crack configuration is a through the thickness center cracked panel. No output beyond the normally supplied out is requested for these runs. The output is shown on pages B-7 through B-10.

Example 2 - D6AC - Retard/No Retard/with DaDt

A second example consisting of a series of three runs is presented on pages B-12 through B-21. Page B-11 is the input for these three runs. For these runs data on every other block is requested and the output was rather extensive. All the information was not needed here and therefore only the first and last page of output of those runs discussed are reproduced. Note that only the third run requires 2 material property types, but that both sets of material data are read in the first run. This simplifies the data input by making it unnecessary to input any material property data for run 3.

The first run has two loading steps, calls for a retardation model (Willenborg) and requests a maximum of three iterations to find a thickness compatible with the design life. A rather low (compared to the "Paris exponent") convergence exponent of 2 was used. The output for the first iteration is shown on pages B-13 through B-14 and the report on the iteration is shown on page B-15. Due to the use of the excessively low value of the convergence exponent, the thickness has not converged to the appropriate value. Note, however, that the information is still quite useful and that a simple hand plot of the result will show the correct thickness.

In the second run retardation was suppressed and no iteration was requested. Note that the life for a thickness of .5 inches

goes from 194 blocks with retardation to 114 blocks without retardation.

In the third run a step which simulated a 480 second hold at a constant load with a resulting sustained load crack growth was included. The crack growth model was assumed to follow a "Paris" format ( $NEQ = 2$ ) with an exponent of 1 and an appropriate constant was assumed. As can be seen by the results, the life was reduced further under these assumptions.

Example 3 - D6AC Iteration on Crack Size/Proof Test.

In this two run example, a part through crack under a single level of loading was considered. The output requested was for every tenth block. In the first run a design iteration in crack size in which the crack shape remains constant was called for. In this case the convergence parameter chosen was appropriate and the design conditions were met in the first iteration. The output for the initial run, the first iteration and the iteration report are given on pages B-23 through B-26.

In the second run a proof loading was considered. The output for this is given on pages B-27 and B-28.

Example 4 - D6AC Pin Loaded Lug with Plotting.

In this single run session a pin loaded lug with two internal cracks was considered. Plotted output every 500 (nominal)

cycles was requested. Tabulated data every 10 blocks was also requested. Note that the input loading is 50 Kips (not 50 Ksi). As can be seen by the data output the cracks transition to through cracks halfway through their crack growth lives. The data to be plotted is shown on page B-34. The first column is "a", the second "c" and the third is the number of cycles.

#### Example 5 - Tabular Input Examples

In this example; three runs, each requiring tabular input data of different types is shown. In the first run a part through crack using the solutions for the stress intensity factor which are in the program was considered. However, the crack growth rate data was input as a table. Three values of stress ratio and eight values of stress intensity range were used.

In the second run, the same material properties as in the first run were considered but the geometry was changed to a through crack that required a tabular input. The tabular input chosen was picked to simulate the consideration of two factors (e.g., the effect of a stiffener and the effect of a finite width) the first table decreases and then increases, the second table increases monotonically. Note that the number of tables input (2) is determined by the numerical value on the type 8 card and the

and the fact that this is a through crack.

In the last example, the geometry is changed once again. This time we have a part through crack that requires tabular input. Note that although the type 8 card value of NKTMX is 1, two tables are required since this is a part through crack.

1234567890123456789012345678901234567890123456789012345678901234567890

1	2219 AL	70 DEG AND -320 DEG	PART-THRU CRACK AND CENTER CRACK			
2	2	100 100	1			
3	1.	0	1	1	1	
4	2	0 30.				
5	30.	0.	1000.	1		
5	30.	0.	1000.	2		
6	1	1				
7	99.	1.	.2	.3		
15	2					
16	50.	1	0	0 40.	3.5	40.
23	2.2E-09					3.5
23	3.3					
23	40.					
23	3.5					
16	70.	1	0	0 50.	5.5	50.
23	8.9E-12					5.5
23	4.92					
23	50.					
23	5.5					
3	1.	0	0	1	0	
6	3	1				
7	6.	.5	.25			

11111111111222222222223333333333344444444445555555555666666666677777777778  
123-567890123-567890123-567890123-5678901234567890123456789012345678901234567890

Column Number

RUN 1 OF 2 RUNS

2219 AL 70 DEG AND -320 DEG PART-THRU CRACK AND CENTER CRACK

LOAD INPUT DATA

STRESS FACTOR 1.000E 00  
LIMIT STRESS 3.000E 01

STEP MAX STRESS MIN STRESS UNITS(CYCLES) MATERIAL TYPE

1 3.000E 01 0.0 1.000E 03 1  
2 3.000E 01 0.0 1.000E 03 2

GEOMETRY INPUT DATA

CRACK TYPE PTC = 1  
WIDTH 9.900E 01  
ADDITIONAL DIMENSION 0.0  
RADIUS/NOTCH DEPTH 0.0  
THICKNESS 1.000E 00  
CRACK DEPTH 3.000E-01  
HALF CRACK LENGTH 2.000E-01

MATERIAL INPUT DATA

B-7

MATERIAL TYPE	YIELD STRENGTH	GROWTH EQUATION	RETARDATION MODEL	CRITICAL STRESS INTENSITY (SURFACE)	THRESHOLD STRESS INTENSITY (SURFACE)	CRITICAL STRESS INTENSITY (DEPTH)	THRESHOLD STRESS INTENSITY (DEPTH)
1	5.000E 01	1	0	4.000E 01	3.500E 00	4.000E 01	3.500E 00
2	7.000E 01	1	0	5.000E 01	5.500E 00	5.000E 01	5.500E 00

CONSTANT NUMBER	MATERIAL TYPE	CRACK GROWTH RATE		RETARDATION MODEL	
		SURFACE	DEPTH	SURFACE	DEPTH
1	1	2.200E-09	2.200E-09	0.0	0.0
2	1	3.300E 00	3.300E 00	0.0	0.0
3	1	4.000E 01	4.000E 01	0.0	0.0
4	1	3.500E 00	3.500E 00	0.0	0.0
1	2	8.900E-12	8.900E-12	0.0	0.0
2	2	4.820E 00	4.820E 00	0.0	0.0
3	2	5.000E 01	5.000E 01	0.0	0.0
4	2	5.500E 00	5.500E 00	0.0	0.0

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RUN 1 2219 AL 70 DEG AND -320 DEG PART-THRU CRACK AND CENTER CRACK

CRACK IS A PART THRU CRACK

BLOCK	STEP	CYCLES	HALF SURFACE CRACK LENGTH (IN)	CRACK DEPTH (IN)	KMAX-SURFACE (KSI ROOT-IN)	KMAX-DEPTH (KSI ROOT-IN)	SURFACE GROWTH RATE (IN/CYCLE)	DEPTH GROWTH RATE (IN/CYCLE)
1	1	0.0	2.000E-01	3.000E-01	2.051E 01	1.621E 01	5.407E-05	2.214E-05
1	1	1.000E 03	2.637E-01	3.269E-01	2.224E 01	1.829E 01	7.672E-05	3.440E-05
1	2	0.0	2.637E-01	3.269E-01	2.237E 01	1.847E 01	2.958E-05	1.132E-05
1	2	1.000E 03	2.954E-01	3.395E-01	2.304E 01	1.932E 01	3.448E-05	1.414E-05

LIMIT LOAD FRACTURE OCCURS IN THE 3 BLOCK 1 STEP AFTER 6.139E 02 CYCLES

CRITICAL K AT DEPTH HAS BEEN EXCEEDED IN THE 3 BLOCK AND THE 1 STEP AFTER 6.139E 02 CYCLES

RUN 2 OF 2 RUNS

2219 AL 70 DEG AND -320 DEG PART-THRU CRACK AND CENTER CRACK

# LOAD INPUT DATA

STRESS FACTOR 1.000E 00  
LIMIT STRESS 3.000E 01

STEP	MAX STRESS	MIN STRESS	UNITS(CYCLES)	MATERIAL TYPE
------	------------	------------	---------------	---------------

1	3.000E 01	0.0	1.000E 03	1
2	3.000E 01	0.0	1.000E 03	2

# GEOMETRY INPUT DATA

CRACK TYPE TC 1  
WIDTH 6.000E 00  
ADDITIONAL DIMENSION 0.0  
RADIUS/NOTCH DEPTH 0.0  
THICKNESS 5.000E-01  
HALF CRACK LENGTH 2.500E-01

# MATERIAL INPUT DATA

MATERIAL TYPE	YIELD STRENGTH	GROWTH EQUATION	RETARDATION MODEL	CRITICAL STRESS INTENSITY (SURFACE)	THRESHOLD STRESS INTENSITY (SURFACE)	CRITICAL STRESS INTENSITY (DEPTH)	THRESHOLD STRESS INTENSITY (DEPTH)
1	5.000E 01	1	0	4.000E 01	3.500E 00	4.000E 01	3.500E 00
2	7.000E 01	1	0	5.000E 01	5.500E 00	5.000E 01	5.500E 00

CONSTANT NUMBER	MATERIAL TYPE	CRACK GROWTH RATE		RETARDATION MODEL	
		SURFACE	DEPTH	SURFACE	DEPTH
1	1	2.200E-09	2.200E-09	0.0	0.0
2	1	3.300E 00	3.300E 00	0.0	0.0
3	1	4.000E 01	4.000E 01	0.0	0.0
4	1	3.500E 00	3.500E 00	0.0	0.0
1	2	8.900E-12	8.900E-12	0.0	0.0
2	2	4.820E 00	4.820E 00	0.0	0.0
3	2	5.000E 01	5.000E 01	0.0	0.0
4	2	5.500E 00	5.500E 00	0.0	0.0

ORIGINAL PART OF POOR QUALITY

RUN 2 2219 AL 70 DEG AND -320 DEG PART-THRU CRACK AND CENTER CRACK

CRACK IS A THROUGH CRACK

BLOCK	STEP	CYCLES	HALF CRACK LENGTH (IN)	KMAX (KSI ROOT-IN)	CRACK GROWTH RATE (IN/CYCLE)
1	1	0.0	2.500E-01	2.677E 01	1.994E-04

LIMIT LOAD FRACTURE OCCURS IN THE 1 BLOCK 1 STEP AFTER 3.691E 02 CYCLES

CRITICAL K AT SURFACE HAS BEEN EXCEEDED IN THE 1 BLOCK AND THE 1 STEP AFTER 3.691E 02 CYCLES

11111111112222222222333333333344444444445555555555666666666677777777778  
 1234567890123456789012345678901234567890123456789012345678901234567890

1	C6AC-REIARD / NO PEIARD / WITH DADT									
2	3	500	2	1						
3	1.		1	1	1	1	1	3	2.	200.
4	2	0 180.								
5	150.	0.		4.			1			
5	100.	0.		20.			1			
6	1	1								
7	90.	.5		.075			.05			
15	2									Run 1
16	190.		1	1	0	90.	6.	90.	6.	
23	7.5E-10									
23	2.74									
23	90.									
23	4.									END
25	1.									END
16	190.		2	0	0	90.	0.	90.	0.	
23	4.0E-00									
23	1.									END
3	1.		0	0	0	0				Run 2
3	1.		0	1	0	0				
4	3	0 180.								
5	150.	0.		4.			1			
5	100.	0.		20.			1			Run 3
5	100.	0.		480.			2			

11111111112222222222333333333344444444445555555555666666666677777777778  
 1234567890123456789012345678901234567890123456789012345678901234567890

Card Type

Column Number

RUN 1 OF 3 RUNS

DAAC-RETARD / NO RETARD / WITH DADT

# LOAD INPUT DATA

STRESS FACTOR 1.000E 00  
LIMIT STRESS 1.800E 02

STEP	MAX STRESS	MIN STRESS	UNITS(CYCLES)	MATERIAL TYPE
------	------------	------------	---------------	---------------

1	1.500E 02	0.0	4.000E 00	1
2	1.000E 02	0.0	2.000E 01	1

# GEOMETRY INPUT DATA

CRACK TYPE PTC = 1  
WIDTH 9.900E 01  
ADDITIONAL DIMENSION 0.0  
RADIUS/NOTCH DEPTH 0.0  
THICKNESS 5.000E-01  
CRACK DEPTH 5.000E-02  
HALF CRACK LENGTH 7.500E-02

# MATERIAL INPUT DATA

MATERIAL TYPE	YIELD STRENGTH	GROWTH EQUATION	RETARDATION MODEL	CRITICAL STRESS INTENSITY (SURFACE)	THRESHOLD STRESS INTENSITY (SURFACE)	CRITICAL STRESS INTENSITY (DEPTH)	THRESHOLD STRESS INTENSITY (DEPTH)
1	1.900E 02	1	1	9.000E 01	6.000E 00	9.000E 01	6.000E 00
2	1.900E 02	2	0	9.000E 01	0.0	9.000E 01	0.0

# EQUATION CONSTANTS

CONSTANT NUMBER	MATERIAL TYPE	CRACK GROWTH RATE		RETARDATION MODEL	
		SURFACE	DEPTH	SURFACE	DEPTH
1	1	7.500E-10	7.500E-10	1.000E 00	1.000E 00
2	1	2.740E 00	2.740E 00	0.0	0.0
3	1	9.000E 01	9.000E 01	0.0	0.0
4	1	6.000E 00	6.000E 00	0.0	0.0
1	2	4.000E-09	4.000E-09	0.0	0.0
2	2	1.000E 00	1.000E 00	0.0	0.0

# ITERATION PARAMETERS

DESIGN LIFE 2.000E 02  
CONVERGENCE EXPONENT 2.000E 00  
ITERATION NUMBER 1  
ITERATION TYPE 1

## CRACK IS A PART THRU CRACK

BLOCK	STEP	CYCLES	HALF SURFACE CRACK LENGTH (IN)	CRACK DEPTH (IN)	KMAX-SURFACE (KSI ROOT-IN)	KMAX-DEPTH (KSI ROOT-IN)	SURFACE GROWTH RATE (IN/CYCLE)	DEPTH GROWTH RATE (IN/CYCLE)
1	1	0.0	7.500E-02	5.000E-02	4.346E 01	5.008E 01	2.659E-05	4.517E-05
1	1	4.000E 00	7.511E-02	5.018E-02	4.346E 01	5.008E 01	2.659E-05	4.517E-05
1	2	0.0	7.511E-02	5.018E-02	2.904E 01	3.341E 01	1.172E-06	1.783E-06
1	2	2.000E 01	7.513E-02	5.022E-02	2.904E 01	3.341E 01	1.172E-06	1.783E-06
2	1	0.0	7.513E-02	5.022E-02	4.358E 01	5.013E 01	2.684E-05	4.534E-05
2	1	4.000E 00	7.524E-02	5.040E-02	4.358E 01	5.013E 01	2.684E-05	4.534E-05
2	2	0.0	7.524E-02	5.040E-02	2.912E 01	3.344E 01	1.182E-06	1.788E-06
2	2	2.000E 01	7.526E-02	5.043E-02	2.912E 01	3.344E 01	1.182E-06	1.788E-06
4	1	0.0	7.539E-02	5.065E-02	4.381E 01	5.022E 01	2.734E-05	4.569E-05
4	1	4.000E 00	7.550E-02	5.083E-02	4.381E 01	5.022E 01	2.734E-05	4.569E-05
4	2	0.0	7.550E-02	5.083E-02	2.927E 01	3.351E 01	1.202E-06	1.798E-06
4	2	2.000E 01	7.553E-02	5.087E-02	2.927E 01	3.351E 01	1.202E-06	1.798E-06
6	1	0.0	7.566E-02	5.109E-02	4.405E 01	5.032E 01	2.786E-05	4.604E-05
6	1	4.000E 00	7.577E-02	5.127E-02	4.405E 01	5.032E 01	2.786E-05	4.604E-05
6	2	0.0	7.577E-02	5.127E-02	2.943E 01	3.357E 01	1.222E-06	1.809E-06
6	2	2.000E 01	7.580E-02	5.131E-02	2.943E 01	3.357E 01	1.222E-06	1.809E-06
8	1	0.0	7.593E-02	5.153E-02	4.428E 01	5.041E 01	2.839E-05	4.640E-05
8	1	4.000E 00	7.605E-02	5.172E-02	4.428E 01	5.041E 01	2.839E-05	4.640E-05
8	2	0.0	7.605E-02	5.172E-02	2.959E 01	3.364E 01	1.242E-06	1.819E-06
8	2	2.000E 01	7.607E-02	5.175E-02	2.959E 01	3.364E 01	1.242E-06	1.819E-06
10	1	0.0	7.621E-02	5.198E-02	4.452E 01	5.051E 01	2.893E-05	4.676E-05
10	1	4.000E 00	7.633E-02	5.216E-02	4.452E 01	5.051E 01	2.893E-05	4.676E-05
10	2	0.0	7.633E-02	5.216E-02	2.974E 01	3.370E 01	1.263E-06	1.830E-06
10	2	2.000E 01	7.635E-02	5.220E-02	2.974E 01	3.370E 01	1.263E-06	1.830E-06
12	1	0.0	7.649E-02	5.242E-02	4.475E 01	5.061E 01	2.947E-05	4.713E-05
12	1	4.000E 00	7.661E-02	5.261E-02	4.475E 01	5.061E 01	2.947E-05	4.713E-05
12	2	0.0	7.661E-02	5.261E-02	2.990E 01	3.376E 01	1.284E-06	1.841E-06
12	2	2.000E 01	7.664E-02	5.265E-02	2.990E 01	3.376E 01	1.284E-06	1.841E-06
14	1	0.0	7.678E-02	5.288E-02	4.499E 01	5.071E 01	3.004E-05	4.750E-05
14	1	4.000E 00	7.690E-02	5.307E-02	4.499E 01	5.071E 01	3.004E-05	4.750E-05
14	2	0.0	7.690E-02	5.307E-02	3.006E 01	3.383E 01	1.305E-06	1.852E-06
14	2	2.000E 01	7.693E-02	5.310E-02	3.006E 01	3.383E 01	1.305E-06	1.852E-06
16	1	0.0	7.708E-02	5.333E-02	4.522E 01	5.080E 01	3.061E-05	4.788E-05
16	1	4.000E 00	7.720E-02	5.352E-02	4.522E 01	5.080E 01	3.061E-05	4.788E-05
16	2	0.0	7.720E-02	5.352E-02	3.022E 01	3.390E 01	1.326E-06	1.863E-06
16	2	2.000E 01	7.723E-02	5.356E-02	3.022E 01	3.390E 01	1.326E-06	1.863E-06
18	1	0.0	7.738E-02	5.379E-02	4.546E 01	5.090E 01	3.119E-05	4.827E-05
18	1	4.000E 00	7.750E-02	5.398E-02	4.546E 01	5.090E 01	3.119E-05	4.827E-05
18	2	0.0	7.750E-02	5.398E-02	3.037E 01	3.396E 01	1.348E-06	1.874E-06
18	2	2.000E 01	7.753E-02	5.402E-02	3.037E 01	3.396E 01	1.348E-06	1.874E-06
20	1	0.0	7.768E-02	5.425E-02	4.570E 01	5.100E 01	3.179E-05	4.867E-05
20	1	4.000E 00	7.781E-02	5.445E-02	4.570E 01	5.100E 01	3.179E-05	4.867E-05
20	2	0.0	7.781E-02	5.445E-02	3.053E 01	3.403E 01	1.370E-06	1.885E-06
20	2	2.000E 01	7.784E-02	5.448E-02	3.053E 01	3.403E 01	1.370E-06	1.885E-06
22	1	0.0	7.799E-02	5.477E-02	4.594E 01	5.111E 01	3.240E-05	4.907E-05
22	1	4.000E 00	7.812E-02	5.491E-02	4.594E 01	5.111E 01	3.240E-05	4.907E-05
22	2	0.0	7.812E-02	5.491E-02	3.069E 01	3.410E 01	1.392E-06	1.896E-06
22	2	2.000E 01	7.815E-02	5.495E-02	3.069E 01	3.410E 01	1.392E-06	1.896E-06
24	1	0.0	7.831E-02	5.519E-02	4.618E 01	5.121E 01	3.303E-05	4.948E-05
24	1	4.000E 00	7.844E-02	5.538E-02	4.618E 01	5.121E 01	3.303E-05	4.948E-05
24	2	0.0	7.844E-02	5.538E-02	3.085E 01	3.417E 01	1.414E-06	1.908E-06
24	2	2.000E 01	7.847E-02	5.542E-02	3.085E 01	3.417E 01	1.414E-06	1.908E-06
26	1	0.0	7.863E-02	5.566E-02	4.642E 01	5.131E 01	3.347E-05	4.989E-05

SIGNAL PAGE IS  
POOR QUALITY

180	2	2.000E 01	1.537E-01	1.308E-01	4.878E 01	4.789E 01	4.819E-04	4.573E-06
182	1	0.0	1.555E-01	1.323E-01	7.363E 01	7.229E 01	4.491E-04	3.766E-04
182	1	4.000E 00	1.573E-01	1.338E-01	7.399E 01	7.266E 01	4.721E-04	3.952E-04
182	2	0.0	1.573E-01	1.338E-01	4.938E 01	4.848E 01	5.125E-06	4.852E-06
182	2	2.000E 01	1.574E-01	1.339E-01	4.936E 01	4.844E 01	5.125E-06	4.852E-06
184	1	0.0	1.594E-01	1.356E-01	7.454E 01	7.322E 01	5.099E-04	4.252E-04
184	1	4.000E 00	1.615E-01	1.374E-01	7.491E 01	7.360E 01	5.377E-04	4.477E-04
184	2	0.0	1.615E-01	1.374E-01	5.001E 01	4.914E 01	5.515E-06	5.206E-06
184	2	2.000E 01	1.616E-01	1.375E-01	5.001E 01	4.914E 01	5.515E-06	5.206E-06
186	1	0.0	1.640E-01	1.394E-01	7.557E 01	7.428E 01	5.924E-04	4.912E-04
186	1	4.000E 00	1.664E-01	1.414E-01	7.594E 01	7.467E 01	6.270E-04	5.192E-04
186	2	0.0	1.664E-01	1.414E-01	5.074E 01	4.989E 01	6.038E-06	5.677E-06
186	2	2.000E 01	1.665E-01	1.415E-01	5.074E 01	4.989E 01	6.038E-06	5.677E-06
188	1	0.0	1.693E-01	1.438E-01	7.675E 01	7.551E 01	7.114E-04	5.867E-04
188	1	4.000E 00	1.722E-01	1.462E-01	7.713E 01	7.591E 01	7.571E-04	6.235E-04
188	2	0.0	1.722E-01	1.462E-01	5.159E 01	5.078E 01	6.802E-06	6.353E-06
188	2	2.000E 01	1.723E-01	1.464E-01	5.159E 01	5.078E 01	6.802E-06	6.353E-06
190	1	0.0	1.757E-01	1.492E-01	7.816E 01	7.699E 01	9.025E-04	7.399E-04
190	1	4.000E 00	1.795E-01	1.522E-01	7.893E 01	7.782E 01	1.040E-03	8.509E-04
190	2	0.0	1.795E-01	1.522E-01	5.263E 01	5.189E 01	5.933E-06	5.695E-06
190	2	2.000E 01	1.796E-01	1.524E-01	5.263E 01	5.189E 01	5.933E-06	5.695E-06
192	1	0.0	1.842E-01	1.561E-01	7.993E 01	7.889E 01	1.268E-03	1.052E-03
192	1	4.000E 00	1.896E-01	1.606E-01	8.073E 01	7.975E 01	1.498E-03	1.220E-03
192	2	0.0	1.896E-01	1.606E-01	5.404E 01	5.341E 01	8.160E-06	7.631E-06
192	2	2.000E 01	1.898E-01	1.607E-01	5.404E 01	5.341E 01	8.160E-06	7.631E-06
194	1	0.0	1.973E-01	1.669E-01	8.262E 01	8.181E 01	2.375E-03	1.925E-03
194	1	4.000E 00	2.100E-01	1.772E-01	8.509E 01	8.454E 01	5.316E-03	4.317E-03
194	2	0.0	2.100E-01	1.772E-01	5.673E 01	5.637E 01	7.239E-06	7.104E-06
194	2	2.000E 01	2.107E-01	1.773E-01	5.673E 01	5.637E 01	7.239E-06	7.104E-06

LIMIT LOAD FRACTURE OCCURS IN THE 184 BLOCK 1 STEP AFTER 3.190E 00 CYCLES

CRITICAL K AT DEPTH HAS BEEN EXCEEDED IN THE 195 BLOCK AND THE 1 STEP AFTER 1.835E 00 CYCLES





RUN 2 OF 3 RUNS

0610-RETARD / NO RETARD / WITH DADT

LEAD INPUT DATA

STRESS FACTOR 1.000E 00  
LIMIT STRESS 1.800E 02

STEP MAX STRESS MIN STRESS UNITS(CYCLES) MATERIAL TYPE

1 1.500E 02 0.0 4.000E 00 1  
2 1.000E 02 0.0 2.000E 01 1

GEOMETRY INPUT DATA

CRACK TYPE PTC = 1  
WIDTH 9.900E 01  
ADDITIONAL DIMENSION 0.0  
RADIUS/NOTCH DEPTH 0.0  
THICKNESS 5.000E-01  
CRACK DEPTH 5.000E-02  
HALF CRACK LENGTH 7.500E-02

MATERIAL INPUT DATA

MATERIAL TYPE	YIELD STRENGTH	GROWTH EQUATION	RETARDATION MODEL	CRITICAL STRESS INTENSITY (SURFACE)	THRESHOLD STRESS INTENSITY (SURFACE)	CRITICAL STRESS INTENSITY (DEPTH)	THRESHOLD STRESS INTENSITY (DEPTH)
1	1.900E 02	1	0	9.000E 01	6.000E 00	9.000E 01	6.000E 00
2	1.900E 02	2	0	9.000E 01	0.0	9.000E 01	0.0

EQUATION CONSTANTS

CONSTANT NUMBER	MATERIAL TYPE	CRACK GROWTH RATE		RETARDATION MODEL	
		SURFACE	DEPTH	SURFACE	DEPTH
1	1	7.500E-10	7.500E-10	1.000E 00	1.000E 00
2	1	2.740E 00	2.740E 00	0.0	0.0
3	1	9.000E 01	9.000E 01	0.0	0.0
4	1	6.000E 00	6.000E 00	0.0	0.0
1	2	4.000E-09	4.000E-09	0.0	0.0
2	2	1.000E 00	1.000E 00	0.0	0.0

## CRACK IS A PART THRU CRACK

BLOCK	STP	CYCLES	HALF SURFACE CRACK LENGTH (IN)	CRACK DEPTH (IN)	KMAX=SURFACE (KSI ROOT-IN)	KMAX=DEPTH (KSI ROOT-IN)	SURFACE GROWTH RATE (IN/CYCLE)	DEPTH GROWTH RATE (IN/CYCLE)
1	1	0.0	7.500E-02	5.000E-02	4.346E 01	5.008E 01	2.659E-05	4.517E-05
1	1	4.000E 00	7.511E-02	5.018E-02	4.346E 01	5.008E 01	2.659E-05	4.517E-05
1	2	0.0	7.511E-02	5.018E-02	2.904E 01	3.341E 01	7.694E-06	1.152E-05
1	2	2.000E 01	7.526E-02	5.041E-02	2.904E 01	3.341E 01	7.694E-06	1.152E-05
2	1	0.0	7.526E-02	5.041E-02	4.368E 01	5.017E 01	2.706E-05	4.551E-05
2	1	4.000E 00	7.537E-02	5.059E-02	4.368E 01	5.017E 01	2.706E-05	4.551E-05
2	2	0.0	7.537E-02	5.059E-02	2.919E 01	3.348E 01	7.804E-06	1.158E-05
2	2	2.000E 01	7.552E-02	5.082E-02	2.919E 01	3.348E 01	7.804E-06	1.158E-05
4	1	0.0	7.579E-02	5.124E-02	4.412E 01	5.036E 01	2.803E-05	4.621E-05
4	1	4.000E 00	7.590E-02	5.143E-02	4.412E 01	5.036E 01	2.803E-05	4.621E-05
4	2	0.0	7.590E-02	5.143E-02	2.948E 01	3.360E 01	8.027E-06	1.171E-05
4	2	2.000E 01	7.607E-02	5.166E-02	2.948E 01	3.360E 01	8.027E-06	1.171E-05
6	1	0.0	7.634E-02	5.208E-02	4.456E 01	5.055E 01	2.904E-05	4.693E-05
6	1	4.000E 00	7.646E-02	5.227E-02	4.456E 01	5.055E 01	2.904E-05	4.693E-05
6	2	0.0	7.646E-02	5.227E-02	2.977E 01	3.373E 01	8.256E-06	1.184E-05
6	2	2.000E 01	7.662E-02	5.251E-02	2.977E 01	3.373E 01	8.256E-06	1.184E-05
8	1	0.0	7.691E-02	5.293E-02	4.501E 01	5.075E 01	3.008E-05	4.766E-05
8	1	4.000E 00	7.703E-02	5.312E-02	4.501E 01	5.075E 01	3.008E-05	4.766E-05
8	2	0.0	7.703E-02	5.312E-02	3.007E 01	3.386E 01	8.491E-06	1.198E-05
8	2	2.000E 01	7.720E-02	5.336E-02	3.007E 01	3.386E 01	8.491E-06	1.198E-05
10	1	0.0	7.749E-02	5.380E-02	4.545E 01	5.094E 01	3.117E-05	4.842E-05
10	1	4.000E 00	7.762E-02	5.399E-02	4.545E 01	5.094E 01	3.117E-05	4.842E-05
10	2	0.0	7.762E-02	5.399E-02	3.037E 01	3.399E 01	8.732E-06	1.212E-05
10	2	2.000E 01	7.779E-02	5.423E-02	3.037E 01	3.399E 01	8.732E-06	1.212E-05
12	1	0.0	7.810E-02	5.467E-02	4.590E 01	5.114E 01	3.230E-05	4.921E-05
12	1	4.000E 00	7.823E-02	5.487E-02	4.590E 01	5.114E 01	3.230E-05	4.921E-05
12	2	0.0	7.823E-02	5.487E-02	3.067E 01	3.412E 01	8.979E-06	1.226E-05
12	2	2.000E 01	7.841E-02	5.511E-02	3.067E 01	3.412E 01	8.979E-06	1.226E-05
14	1	0.0	7.872E-02	5.554E-02	4.635E 01	5.134E 01	3.348E-05	5.002E-05
14	1	4.000E 00	7.885E-02	5.574E-02	4.635E 01	5.134E 01	3.348E-05	5.002E-05
14	2	0.0	7.885E-02	5.574E-02	3.097E 01	3.426E 01	9.232E-06	1.240E-05
14	2	2.000E 01	7.904E-02	5.601E-02	3.097E 01	3.426E 01	9.232E-06	1.240E-05
16	1	0.0	7.936E-02	5.648E-02	4.680E 01	5.155E 01	3.471E-05	5.086E-05
16	1	4.000E 00	7.950E-02	5.666E-02	4.680E 01	5.155E 01	3.471E-05	5.086E-05
16	2	0.0	7.950E-02	5.666E-02	3.127E 01	3.439E 01	9.492E-06	1.255E-05
16	2	2.000E 01	7.969E-02	5.691E-02	3.127E 01	3.439E 01	9.492E-06	1.255E-05
18	1	0.0	8.002E-02	5.737E-02	4.725E 01	5.176E 01	3.598E-05	5.175E-05
18	1	4.000E 00	8.017E-02	5.758E-02	4.725E 01	5.176E 01	3.598E-05	5.175E-05
18	2	0.0	8.017E-02	5.758E-02	3.157E 01	3.454E 01	9.757E-06	1.272E-05
18	2	2.000E 01	8.036E-02	5.783E-02	3.157E 01	3.454E 01	9.757E-06	1.272E-05
20	1	0.0	8.071E-02	5.830E-02	4.769E 01	5.202E 01	3.728E-05	5.287E-05
20	1	4.000E 00	8.086E-02	5.851E-02	4.769E 01	5.202E 01	3.728E-05	5.287E-05
20	2	0.0	8.086E-02	5.851E-02	3.186E 01	3.472E 01	1.002E-05	1.291E-05
20	2	2.000E 01	8.106E-02	5.877E-02	3.186E 01	3.472E 01	1.002E-05	1.291E-05
22	1	0.0	8.141E-02	5.924E-02	4.814E 01	5.229E 01	3.864E-05	5.403E-05
22	1	4.000E 00	8.157E-02	5.946E-02	4.814E 01	5.229E 01	3.864E-05	5.403E-05
22	2	0.0	8.157E-02	5.946E-02	3.216E 01	3.490E 01	1.030E-05	1.311E-05
22	2	2.000E 01	8.177E-02	5.972E-02	3.216E 01	3.490E 01	1.030E-05	1.311E-05
24	1	0.0	8.214E-02	6.020E-02	4.859E 01	5.256E 01	4.007E-05	5.524E-05
24	1	4.000E 00	8.230E-02	6.042E-02	4.859E 01	5.256E 01	4.007E-05	5.524E-05
24	2	0.0	8.230E-02	6.042E-02	3.246E 01	3.508E 01	1.058E-05	1.332E-05
24	2	2.000E 01	8.251E-02	6.069E-02	3.246E 01	3.508E 01	1.058E-05	1.332E-05
26	1	0.0	8.289E-02	6.118E-02	4.905E 01	5.284E 01	4.194E-05	5.650E-05

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98	1	4.000E 00	1.268E-01	1.073E-01	6.604E 01	6.502E 01	1.854E-04	1.672E-04
98	2	0.0	1.268E-01	1.073E-01	4.417E 01	4.347E 01	2.814E-05	2.661E-05
98	2	2.000E 01	1.274E-01	1.078E-01	4.417E 01	4.347E 01	2.814E-05	2.661E-05
90	1	0.0	1.287E-01	1.091E-01	6.681E 01	6.569E 01	2.007E-04	1.789E-04
90	1	4.000E 00	1.295E-01	1.098E-01	6.681E 01	6.569E 01	2.007E-04	1.789E-04
90	2	0.0	1.295E-01	1.098E-01	4.469E 01	4.393E 01	2.932E-05	2.761E-05
90	2	2.000E 01	1.301E-01	1.103E-01	4.469E 01	4.393E 01	2.932E-05	2.761E-05
92	1	0.0	1.315E-01	1.116E-01	6.761E 01	6.641E 01	2.104E-04	1.925E-04
92	1	4.000E 00	1.324E-01	1.124E-01	6.761E 01	6.641E 01	2.104E-04	1.925E-04
92	2	0.0	1.324E-01	1.124E-01	4.523E 01	4.442E 01	3.062E-05	2.870E-05
92	2	2.000E 01	1.330E-01	1.130E-01	4.523E 01	4.442E 01	3.062E-05	2.870E-05
94	1	0.0	1.346E-01	1.144E-01	6.844E 01	6.717E 01	2.391E-04	2.084E-04
94	1	4.000E 00	1.355E-01	1.152E-01	6.844E 01	6.717E 01	2.391E-04	2.084E-04
94	2	0.0	1.355E-01	1.152E-01	4.579E 01	4.494E 01	3.204E-05	2.992E-05
94	2	2.000E 01	1.362E-01	1.158E-01	4.579E 01	4.494E 01	3.204E-05	2.992E-05
96	1	0.0	1.378E-01	1.173E-01	6.932E 01	6.798E 01	2.637E-04	2.273E-04
96	1	4.000E 00	1.389E-01	1.182E-01	6.932E 01	6.798E 01	2.637E-04	2.273E-04
96	2	0.0	1.389E-01	1.182E-01	4.639E 01	4.549E 01	3.360E-05	3.128E-05
96	2	2.000E 01	1.396E-01	1.188E-01	4.639E 01	4.549E 01	3.360E-05	3.128E-05
98	1	0.0	1.414E-01	1.204E-01	7.025E 01	6.885E 01	2.935E-04	2.501E-04
98	1	4.000E 00	1.425E-01	1.214E-01	7.025E 01	6.885E 01	2.935E-04	2.501E-04
98	2	0.0	1.425E-01	1.214E-01	4.702E 01	4.609E 01	3.535E-05	3.281E-05
98	2	2.000E 01	1.432E-01	1.221E-01	4.702E 01	4.609E 01	3.535E-05	3.281E-05
100	1	0.0	1.452E-01	1.238E-01	7.123E 01	6.979E 01	3.303E-04	2.783E-04
100	1	4.000E 00	1.465E-01	1.249E-01	7.123E 01	6.979E 01	3.303E-04	2.783E-04
100	2	0.0	1.465E-01	1.249E-01	4.770E 01	4.674E 01	3.731E-05	3.455E-05
100	2	2.000E 01	1.473E-01	1.256E-01	4.770E 01	4.674E 01	3.731E-05	3.455E-05
102	1	0.0	1.494E-01	1.275E-01	7.229E 01	7.081E 01	3.770E-04	3.139E-04
102	1	4.000E 00	1.510E-01	1.287E-01	7.229E 01	7.081E 01	3.770E-04	3.139E-04
102	2	0.0	1.510E-01	1.287E-01	4.843E 01	4.745E 01	3.956E-05	3.658E-05
102	2	2.000E 01	1.517E-01	1.295E-01	4.843E 01	4.745E 01	3.956E-05	3.658E-05
104	1	0.0	1.542E-01	1.316E-01	7.345E 01	7.195E 01	4.383E-04	3.608E-04
104	1	4.000E 00	1.560E-01	1.330E-01	7.345E 01	7.195E 01	4.383E-04	3.608E-04
104	2	0.0	1.560E-01	1.330E-01	4.923E 01	4.825E 01	4.218E-05	3.898E-05
104	2	2.000E 01	1.568E-01	1.338E-01	4.923E 01	4.825E 01	4.218E-05	3.898E-05
106	1	0.0	1.596E-01	1.362E-01	7.472E 01	7.323E 01	5.232E-04	4.256E-04
106	1	4.000E 00	1.617E-01	1.379E-01	7.472E 01	7.323E 01	5.232E-04	4.256E-04
106	2	0.0	1.617E-01	1.379E-01	5.012E 01	4.915E 01	4.533E-05	4.191E-05
106	2	2.000E 01	1.626E-01	1.387E-01	5.012E 01	4.915E 01	4.533E-05	4.191E-05
108	1	0.0	1.659E-01	1.415E-01	7.617E 01	7.470E 01	6.490E-04	5.218E-04
108	1	4.000E 00	1.686E-01	1.436E-01	7.617E 01	7.470E 01	6.490E-04	5.218E-04
108	2	0.0	1.686E-01	1.436E-01	5.115E 01	5.021E 01	4.926E-05	4.565E-05
108	2	2.000E 01	1.695E-01	1.445E-01	5.115E 01	5.021E 01	4.926E-05	4.565E-05
110	1	0.0	1.736E-01	1.479E-01	7.787E 01	7.647E 01	8.579E-04	6.810E-04
110	1	4.000E 00	1.771E-01	1.507E-01	7.787E 01	7.647E 01	8.579E-04	6.810E-04
110	2	0.0	1.771E-01	1.507E-01	5.239E 01	5.152E 01	5.449E-05	5.077E-05
110	2	2.000E 01	1.782E-01	1.518E-01	5.239E 01	5.152E 01	5.449E-05	5.077E-05
112	1	0.0	1.837E-01	1.562E-01	8.000E 01	7.876E 01	1.284E-03	1.007E-03
112	1	4.000E 00	1.892E-01	1.606E-01	8.079E 01	7.966E 01	1.518E-03	1.197E-03
112	2	0.0	1.892E-01	1.606E-01	5.406E 01	5.333E 01	6.249E-05	5.887E-05
112	2	2.000E 01	1.905E-01	1.618E-01	5.406E 01	5.333E 01	6.249E-05	5.887E-05
114	1	0.0	1.998E-01	1.693E-01	8.325E 01	8.239E 01	2.837E-03	2.197E-03
114	1	4.000E 00	2.175E-01	1.833E-01	8.614E 01	8.568E 01	8.464E-03	6.796E-03
114	2	0.0	2.175E-01	1.833E-01	5.769E 01	5.742E 01	8.501E-05	8.302E-05
114	2	2.000E 01	2.192E-01	1.849E-01	5.769E 01	5.742E 01	8.501E-05	8.302E-05

LIMIT LOAD FRACTURE OCCURS IN THE 106 BLOCK 1 STEP AFTER 3.200E 00 CYCLES

CRITICAL K AT DEPTH HAS BEEN EXCEEDED IN THE 115 BLOCK AND THE 1 STEP AFTER 5.410E-01 CYCLES

RUN 3 OF 3 RUNS

DAAC-RETARD / NO RETARD / WITH DAAT

LOAD INPUT DATA

STRESS FACTOR 1.000E 00  
LIMIT STRESS 1.800E 02

STEP MAX STRESS MIN STRESS UNITS(CYCLES) MATERIAL TYPE

1	1.500E 02	0.0	4.000E 00	1
2	1.000E 02	0.0	2.000E 01	1
3	1.000E 02	0.0	4.000E 02	2

GEOMETRY INPUT DATA

CRACK TYPE PTC - 1  
WIDTH 9.000E 01  
ADDITIONAL DIMENSION 0.0  
RADIUS/NOTCH DEPTH 0.0  
THICKNESS 5.000E-01  
CRACK DEPTH 5.000E-02  
HALF CRACK LENGTH 7.500E-02

MATERIAL INPUT DATA

MATERIAL TYPE	YIELD STRENGTH	GROWTH EQUATION	RETARDATION MODEL	CRITICAL STRESS INTENSITY (SURFACE)	THRESHOLD STRESS INTENSITY (SURFACE)	CRITICAL STRESS INTENSITY (DEPTH)	THRESHOLD STRESS INTENSITY (DEPTH)
1	1.900E 02	1	0	9.000E 01	6.000E 00	9.000E 01	6.000E 00
2	1.900E 02	2	0	9.000E 01	0.0	9.000E 01	0.0

CONSTANT NUMBER	MATERIAL TYPE	CRACK GROWTH RATE		RETARDATION MODEL	
		SURFACE	DEPTH	SURFACE	DEPTH
1	1	7.500E-10	7.500E-10	1.000E 00	1.000E 00
2	1	2.740E 00	2.740E 00	0.0	0.0
3	1	9.000E 01	9.000E 01	0.0	0.0
4	1	6.000E 00	6.000E 00	0.0	0.0
1	2	4.000E-09	4.000E-09	0.0	0.0
2	2	1.000E 00	1.000E 00	0.0	0.0

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CRACK IS A PART THRU CRACK

BLOCK	STEP	CYCLES	HALF SURFACE CRACK LENGTH (IN)	CRACK DEPTH (IN)	KMAX-SURFACE (KSI ROOT-IN)	KMAX-DEPTH (KSI ROOT-IN)	SURFACE GROWTH RATE (IN/CYCLE)	DEPTH GROWTH RATE (IN/CYCLE)
1	1	0.0	7.500E-02	5.000E-02	4.346E 01	5.008E 01	2.659E-05	4.517E-05
1	1	4.000E 00	7.511E-02	5.018E-02	4.346E 01	5.008E 01	2.659E-05	4.517E-05
1	2	0.0	7.511E-02	5.018E-02	2.904E 01	3.341E 01	7.694E-06	1.152E-05
1	2	2.000E 01	7.526E-02	5.041E-02	2.904E 01	3.341E 01	7.694E-06	1.152E-05
1	3	0.0	7.526E-02	5.041E-02	2.912E 01	3.345E 01	1.165E-07	1.338E-07
1	3	4.800E 02	7.532E-02	5.048E-02	2.912E 01	3.345E 01	1.165E-07	1.338E-07
2	1	0.0	7.532E-02	5.048E-02	4.372E 01	5.019E 01	2.713E-05	4.558E-05
2	1	4.000E 00	7.542E-02	5.066E-02	4.372E 01	5.019E 01	2.713E-05	4.558E-05
2	2	0.0	7.542E-02	5.066E-02	2.921E 01	3.349E 01	7.820E-06	1.160E-05
2	2	2.000E 01	7.558E-02	5.089E-02	2.921E 01	3.349E 01	7.820E-06	1.160E-05
2	3	0.0	7.558E-02	5.089E-02	2.929E 01	3.353E 01	1.172E-07	1.341E-07
2	3	4.800E 02	7.564E-02	5.095E-02	2.929E 01	3.353E 01	1.172E-07	1.341E-07
4	1	0.0	7.596E-02	5.144E-02	4.422E 01	5.042E 01	2.825E-05	4.643E-05
4	1	4.000E 00	7.608E-02	5.162E-02	4.422E 01	5.042E 01	2.825E-05	4.643E-05
4	2	0.0	7.608E-02	5.162E-02	2.955E 01	3.364E 01	8.077E-06	1.175E-05
4	2	2.000E 01	7.624E-02	5.186E-02	2.955E 01	3.364E 01	8.077E-06	1.175E-05
4	3	0.0	7.624E-02	5.186E-02	2.963E 01	3.368E 01	1.185E-07	1.347E-07
4	3	4.800E 02	7.629E-02	5.192E-02	2.963E 01	3.368E 01	1.185E-07	1.347E-07
6	1	0.0	7.663E-02	5.241E-02	4.473E 01	5.065E 01	2.942E-05	4.730E-05
6	1	4.000E 00	7.675E-02	5.260E-02	4.473E 01	5.065E 01	2.942E-05	4.730E-05
6	2	0.0	7.675E-02	5.260E-02	2.988E 01	3.379E 01	8.342E-06	1.191E-05
6	2	2.000E 01	7.692E-02	5.284E-02	2.988E 01	3.379E 01	8.342E-06	1.191E-05
6	3	0.0	7.692E-02	5.284E-02	2.997E 01	3.383E 01	1.199E-07	1.353E-07
6	3	4.800E 02	7.697E-02	5.290E-02	2.997E 01	3.383E 01	1.199E-07	1.353E-07
8	1	0.0	7.737E-02	5.340E-02	4.523E 01	5.088E 01	3.064E-05	4.820E-05
8	1	4.000E 00	7.744E-02	5.359E-02	4.523E 01	5.088E 01	3.064E-05	4.820E-05
8	2	0.0	7.744E-02	5.359E-02	3.022E 01	3.395E 01	8.614E-06	1.208E-05
8	2	2.000E 01	7.762E-02	5.383E-02	3.022E 01	3.395E 01	8.614E-06	1.208E-05
8	3	0.0	7.762E-02	5.383E-02	3.031E 01	3.399E 01	1.212E-07	1.360E-07
8	3	4.800E 02	7.767E-02	5.390E-02	3.031E 01	3.399E 01	1.212E-07	1.360E-07
10	1	0.0	7.803E-02	5.440E-02	4.575E 01	5.112E 01	3.191E-05	4.913E-05
10	1	4.000E 00	7.816E-02	5.460E-02	4.575E 01	5.112E 01	3.191E-05	4.913E-05
10	2	0.0	7.816E-02	5.460E-02	3.056E 01	3.411E 01	8.894E-06	1.224E-05
10	2	2.000E 01	7.834E-02	5.484E-02	3.056E 01	3.411E 01	8.894E-06	1.224E-05
10	3	0.0	7.834E-02	5.484E-02	3.065E 01	3.415E 01	1.226E-07	1.366E-07
10	3	4.800E 02	7.840E-02	5.491E-02	3.065E 01	3.415E 01	1.226E-07	1.366E-07
12	1	0.0	7.877E-02	5.542E-02	4.626E 01	5.136E 01	3.325E-05	5.009E-05
12	1	4.000E 00	7.890E-02	5.562E-02	4.626E 01	5.136E 01	3.325E-05	5.009E-05
12	2	0.0	7.890E-02	5.562E-02	3.097E 01	3.427E 01	9.182E-06	1.242E-05
12	2	2.000E 01	7.908E-02	5.587E-02	3.097E 01	3.427E 01	9.182E-06	1.242E-05
12	3	0.0	7.908E-02	5.587E-02	3.099E 01	3.431E 01	1.240E-07	1.372E-07
12	3	4.800E 02	7.914E-02	5.593E-02	3.099E 01	3.431E 01	1.240E-07	1.372E-07
14	1	0.0	7.952E-02	5.645E-02	4.677E 01	5.160E 01	3.464E-05	5.109E-05
14	1	4.000E 00	7.966E-02	5.666E-02	4.677E 01	5.160E 01	3.464E-05	5.109E-05
14	2	0.0	7.966E-02	5.666E-02	3.125E 01	3.443E 01	9.479E-06	1.259E-05
14	2	2.000E 01	7.985E-02	5.691E-02	3.125E 01	3.443E 01	9.479E-06	1.259E-05
14	3	0.0	7.985E-02	5.691E-02	3.133E 01	3.447E 01	1.253E-07	1.379E-07
14	3	4.800E 02	7.991E-02	5.697E-02	3.133E 01	3.447E 01	1.253E-07	1.379E-07
16	1	0.0	8.031E-02	5.750E-02	4.729E 01	5.185E 01	3.610E-05	5.212E-05
16	1	4.000E 00	8.045E-02	5.771E-02	4.729E 01	5.185E 01	3.610E-05	5.212E-05
16	2	0.0	8.045E-02	5.771E-02	3.159E 01	3.460E 01	9.783E-06	1.278E-05
16	2	2.000E 01	8.065E-02	5.796E-02	3.159E 01	3.460E 01	9.783E-06	1.278E-05
16	3	0.0	8.065E-02	5.796E-02	3.168E 01	3.465E 01	1.267E-07	1.386E-07

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100	1	4.000E 00	1.798E-01	1.530E-01	7.916E 01	7.788E 01	1.087E-03	8.596E-04
100	2	0.0	1.798E-01	1.530E-01	5.279E 01	5.193E 01	5.628E-05	5.248E-05
100	2	2.000E 01	1.810E-01	1.541E-01	5.279E 01	5.193E 01	5.628E-05	5.248E-05
100	3	0.0	1.810E-01	1.541E-01	5.297E 01	5.210E 01	2.119E-07	2.084E-07
100	3	4.800E 02	1.811E-01	1.542E-01	5.297E 01	5.210E 01	2.119E-07	2.084E-07
102	1	0.0	1.873E-01	1.593E-01	8.077E 01	7.956E 01	1.512E-03	1.174E-03
102	1	4.000E 00	1.940E-01	1.645E-01	8.196E 01	8.094E 01	1.998E-03	1.572E-03
102	2	0.0	1.940E-01	1.645E-01	5.470E 01	5.404E 01	6.593E-05	6.238E-05
102	2	2.000E 01	1.953E-01	1.657E-01	5.470E 01	5.404E 01	6.593E-05	6.238E-05
102	3	0.0	1.953E-01	1.657E-01	5.491E 01	5.422E 01	2.197E-07	2.169E-07
102	3	4.800E 02	1.954E-01	1.658E-01	5.491E 01	5.422E 01	2.197E-07	2.169E-07
104	1	0.0	2.083E-01	1.762E-01	8.490E 01	8.416E 01	4.928E-03	3.781E-03

LIMIT LOAD FRACTURE OCCURS IN THE 95 BLOCK 2 STEP AFTER 0.0 CYCLES

CRITICAL K AT DEPTH HAS BEEN EXCEEDED IN THE 104 BLOCK AND THE 1 STEP AFTER 2.179E 00 CYCLES

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111111111112222222222333333333344444444455555555566666666677777777778  
1234567890123456789012345678901234567890123456789012345678901234567890

1	DAAC	ITERATION ON CRACK SIZE / PROOF TEST															
2	2	1000	10	1													
3	1.		0	1	1	1	4	10	4.					200.			
4	1	0	180.														
5	120.		0.			25.			1								
6	1	1															
7	09.		.5			.075			.05								
15	1																
16	190.		1	0	0	90.			6.		90.		6.				Run 1
23	7.5E-10																
23	2.74																
23	90.																
23	6.																END
3	1.		0	0	0	0											
27	.333		70.		90.			0.		.5		180.					Run 2

111111111112222222222333333333344444444455555555566666666677777777778  
1234567890123456789012345678901234567890123456789012345678901234567890

Card Type

Column Number

RUN 1 OF 2 RUNS D6AC ITERATION (W CRACK SIZE / PROOF TEST

# LOAD INPUT DATA

STRESS FACTOR 1.000E 00  
LIMIT STRESS 1.800E 02

STEP MAX STRESS MIN STRESS UNITS(CYCLES) MATERIAL TYPE

1 1.200E 02 0.0 2.500E 01 1

# GEOMETRY INPUT DATA

CRACK TYPE PTC - 1  
WIDTH 9.900E 01  
ADDITIONAL DIMENSION 0.0  
RADIUS/NOTCH DEPTH 0.0  
THICKNESS 5.000E-01  
CRACK DEPTH 5.000E-02  
HALF CRACK LENGTH 7.500E-02

# MATERIAL INPUT DATA

MATERIAL TYPE	YIELD STRENGTH	GROWTH EQUATION	RETARDATION MODEL	CRITICAL STRESS INTENSITY (SURFACE)	THRESHOLD STRESS INTENSITY (SURFACE)	CRITICAL STRESS INTENSITY (DEPTH)	THRESHOLD STRESS INTENSITY (DEPTH)
1	1.900E 02	1	0	9.000E 01	6.000E 00	9.000E 01	6.000E 00

# EQUATION CONSTANTS

CONSTANT NUMBER	MATERIAL TYPE	CRACK GROWTH RATE		RETARDATION MODEL	
		SURFACE	DEPTH	SURFACE	DEPTH
1	1	7.500E-10	7.500E-10	0.0	0.0
2	1	2.740E 00	2.740E 00	0.0	0.0
3	1	9.000E 01	9.000E 01	0.0	0.0
4	1	6.000E 00	6.000E 00	0.0	0.0

# ITERATION PARAMETERS

DESIGN LIFE 2.000E 02  
CONVERGENCE EXPONENT 4.000E 00  
ITERATION NUMBER 1  
ITERATION TYPE 4



RUN 1

DAAC ITERATION ON CRACK SIZE / PROOF TEST

CRACK IS A PART THRU CRACK

BLOCK	STEP	CYCLES	HALF SURFACE CRACK LENGTH (IN)	CRACK DEPTH (IN)	KMAX-SURFACE (KSI ROOT-IN)	KMAX-DEPTH (KSI ROOT-IN)	SURFACE GROWTH RATE (IN/CYCLE)	DEPTH GROWTH RATE (IN/CYCLE)
1	1	0.0	7.500E-02	5.000E-02	7.477E 01	4.007E 01	1.297E-05	2.020E-05
1	1	2.500E 01	7.532E-02	5.051E-02	3.498E 01	4.016E 01	1.321E-05	2.036E-05
10	1	0.0	7.815E-02	5.469E-02	3.672E 01	4.093E 01	1.532E-05	2.167E-05
10	1	2.500E 01	7.853E-02	5.523E-02	3.672E 01	4.093E 01	1.532E-05	2.167E-05
20	1	0.0	8.231E-02	6.033E-02	3.891E 01	4.209E 01	1.838E-05	2.381E-05
20	1	2.500E 01	8.277E-02	6.092E-02	3.891E 01	4.209E 01	1.838E-05	2.381E-05
30	1	0.0	8.731E-02	6.659E-02	4.118E 01	4.351E 01	2.212E-05	2.668E-05
30	1	2.500E 01	8.786E-02	6.725E-02	4.141E 01	4.366E 01	2.255E-05	2.700E-05
40	1	0.0	9.334E-02	7.362E-02	4.351E 01	4.497E 01	2.669E-05	3.001E-05
40	1	2.500E 01	9.401E-02	7.437E-02	4.375E 01	4.513E 01	2.720E-05	3.037E-05
50	1	0.0	1.006E-01	8.158E-02	4.596E 01	4.662E 01	3.246E-05	3.423E-05
50	1	2.500E 01	1.014E-01	8.243E-02	4.620E 01	4.679E 01	3.310E-05	3.470E-05
60	1	0.0	1.096E-01	9.075E-02	4.861E 01	4.857E 01	4.012E-05	4.000E-05
60	1	2.500E 01	1.106E-01	9.175E-02	4.886E 01	4.876E 01	4.095E-05	4.063E-05
70	1	0.0	1.208E-01	1.016E-01	5.155E 01	5.092E 01	5.088E-05	4.836E-05
70	1	2.500E 01	1.220E-01	1.029E-01	5.182E 01	5.115E 01	5.198E-05	4.923E-05
80	1	0.0	1.352E-01	1.151E-01	5.494E 01	5.386E 01	6.729E-05	6.146E-05
80	1	2.500E 01	1.369E-01	1.167E-01	5.522E 01	5.411E 01	6.888E-05	6.275E-05
90	1	0.0	1.551E-01	1.329E-01	5.910E 01	5.770E 01	9.609E-05	8.505E-05
90	1	2.500E 01	1.575E-01	1.351E-01	5.939E 01	5.798E 01	9.865E-05	8.717E-05
100	1	0.0	1.856E-01	1.596E-01	6.479E 01	6.330E 01	1.633E-04	1.413E-04
100	1	2.500E 01	1.898E-01	1.637E-01	6.544E 01	6.395E 01	1.743E-04	1.505E-04
110	1	0.0	2.581E-01	2.221E-01	7.641E 01	7.549E 01	6.746E-04	5.850E-04
110	1	2.500E 01	2.791E-01	2.404E-01	7.913E 01	7.844E 01	1.080E-03	9.498E-04

LIMIT LOAD FRACTURE OCCURS IN THE 91 BLOCK 1 STEP AFTER 1.526E 01 CYCLES

CRITICAL K AT DEPTH HAS BEEN EXCEEDED IN THE 111 BLOCK AND THE 1 STEP AFTER 2.168E 01 CYCLES

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RUN 1

06AC ITERATION ON CRACK SIZE / PROOF TEST

CRACK IS A PART THRU CRACK

BLOCK	STEP	CYCLES	HALF SURFACE CRACK LENGTH (IN)	CRACK DEPTH (IN)	KMAX-SURFACE (KSI ROOT-IN)	KMAX-DEPTH (KSI ROOT-IN)	SURFACE GROWTH RATE (IN/CYCLE)	DEPTH GROWTH RATE (IN/CYCLE)
1	1	0.0	4.15FE-02	2.772E-02	2.589E 01	2.979E 01	5.588E-06	8.267E-06
1	1	2.500E 01	4.171E-02	2.792E-02	2.549E 01	2.979E 01	5.588E-06	8.267E-06
10	1	0.0	4.290E-02	2.967E-02	2.895E 01	3.028E 01	6.243E-06	8.659E-06
10	1	2.500E 01	4.305E-02	2.983E-02	2.895E 01	3.028E 01	6.243E-06	8.659E-06
20	1	0.0	4.455E-02	3.183E-02	2.814E 01	3.085E 01	7.041E-06	9.135E-06
20	1	2.500E 01	4.472E-02	3.206E-02	2.814E 01	3.085E 01	7.041E-06	9.135E-06
30	1	0.0	4.640E-02	3.419E-02	2.932E 01	3.158E 01	7.904E-06	9.766E-06
30	1	2.500E 01	4.660E-02	3.443E-02	2.932E 01	3.158E 01	7.904E-06	9.766E-06
40	1	0.0	4.848E-02	3.671E-02	3.053E 01	3.236E 01	8.869E-06	1.048E-05
40	1	2.500E 01	4.871E-02	3.697E-02	3.053E 01	3.236E 01	8.869E-06	1.048E-05
50	1	0.0	5.082E-02	3.941E-02	3.177E 01	3.317E 01	9.942E-06	1.127E-05
50	1	2.500E 01	5.107E-02	3.970E-02	3.177E 01	3.317E 01	9.942E-06	1.127E-05
60	1	0.0	5.343E-02	4.232E-02	3.301E 01	3.397E 01	1.111E-05	1.210E-05
60	1	2.500E 01	5.371E-02	4.263E-02	3.301E 01	3.397E 01	1.111E-05	1.210E-05
70	1	0.0	5.636E-02	4.545E-02	3.428E 01	3.485E 01	1.243E-05	1.306E-05
70	1	2.500E 01	5.667E-02	4.578E-02	3.428E 01	3.485E 01	1.243E-05	1.306E-05
80	1	0.0	5.963E-02	4.884E-02	3.561E 01	3.581E 01	1.394E-05	1.418E-05
80	1	2.500E 01	5.998E-02	4.919E-02	3.561E 01	3.581E 01	1.394E-05	1.418E-05
90	1	0.0	6.331E-02	5.253E-02	3.699E 01	3.685E 01	1.567E-05	1.549E-05
90	1	2.500E 01	6.370E-02	5.291E-02	3.699E 01	3.685E 01	1.567E-05	1.549E-05
100	1	0.0	6.744E-02	5.657E-02	3.844E 01	3.800E 01	1.768E-05	1.705E-05
100	1	2.500E 01	6.788E-02	5.699E-02	3.844E 01	3.800E 01	1.768E-05	1.705E-05
110	1	0.0	7.212E-02	6.103E-02	3.998E 01	3.926E 01	2.006E-05	1.892E-05
110	1	2.500E 01	7.262E-02	6.151E-02	3.998E 01	3.926E 01	2.006E-05	1.892E-05
120	1	0.0	7.744E-02	6.601E-02	4.161E 01	4.066E 01	2.291E-05	2.120E-05
120	1	2.500E 01	7.802E-02	6.654E-02	4.161E 01	4.066E 01	2.291E-05	2.120E-05
130	1	0.0	8.355E-02	7.161E-02	4.338E 01	4.221E 01	2.640E-05	2.405E-05
130	1	2.500E 01	8.421E-02	7.222E-02	4.338E 01	4.221E 01	2.640E-05	2.405E-05
140	1	0.0	9.062E-02	7.802E-02	4.530E 01	4.397E 01	3.079E-05	2.768E-05
140	1	2.500E 01	9.139E-02	7.871E-02	4.530E 01	4.397E 01	3.079E-05	2.768E-05
150	1	0.0	9.893E-02	8.544E-02	4.742E 01	4.595E 01	3.649E-05	3.243E-05
150	1	2.500E 01	9.984E-02	8.625E-02	4.742E 01	4.595E 01	3.649E-05	3.243E-05
160	1	0.0	1.089E-01	9.423E-02	4.981E 01	4.821E 01	4.421E-05	3.887E-05
160	1	2.500E 01	1.100E-01	9.520E-02	5.006E 01	4.845E 01	4.510E-05	3.962E-05
170	1	0.0	1.211E-01	1.049E-01	5.257E 01	5.087E 01	5.530E-05	4.819E-05
170	1	2.500E 01	1.225E-01	1.061E-01	5.284E 01	5.113E 01	5.650E-05	4.915E-05
180	1	0.0	1.388E-01	1.185E-01	5.587E 01	5.411E 01	7.274E-05	6.274E-05
180	1	2.500E 01	1.386E-01	1.201E-01	5.615E 01	5.438E 01	7.447E-05	6.420E-05
190	1	0.0	1.582E-01	1.370E-01	6.005E 01	5.828E 01	1.046E-04	8.948E-05
190	1	2.500E 01	1.609E-01	1.392E-01	6.035E 01	5.859E 01	1.075E-04	9.187E-05
200	1	0.0	1.921E-01	1.658E-01	6.605E 01	6.443E 01	1.856E-04	1.577E-04
200	1	2.500E 01	1.969E-01	1.698E-01	6.671E 01	6.512E 01	1.986E-04	1.688E-04
210	1	0.0	3.028E-01	2.616E-01	8.297E 01	8.263E 01	2.620E-03	2.389E-03

LIMIT LOAD FRACTURE OCCURS IN THE 189 BLOCK 1 STEP AFTER 1.570E 01 CYCLES

CRITICAL K AT DEPTH HAS BEEN EXCEEDED IN THE 210 BLOCK AND THE 1 STEP AFTER 6.695E 00 CYCLES

ORIGINAL PAGE IS  
1000 OF 1000

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# ITERATION RESULTS

THICKNESS	A	C	LIFE	PERCENT OF REQUIRED LIFE
5.000E-01	5.000E-02	7.500E-02	1.109E 02	55.43
5.000E-01	2.772E-02	4.158E-02	2.093E 02	104.63

RUN 2 OF 2 RUNS

D6AC ITERATION ON CRACK SIZE / PROOF TEST

LOAD INPUT DATA

STRESS FACTOR 1.000E 00  
LIMIT STRESS 1.000E 02

STEP MAX STRESS MIN STRESS UNITS(CYCLES) MATERIAL TYPE

1 1.200E 02 0.0 2.500E 01 1

GEOMETRY INPUT DATA

CRACK TYPE PIC - 1  
WIDTH 9.900E 01  
ADDITIONAL DIMENSION 0.0  
RADIUS/NOTCH DEPTH 0.0  
THICKNESS 5.000E-01  
CRACK DEPTH 2.772E-02  
HALF CRACK LENGTH 4.158E-02

MATERIAL INPUT DATA

MATERIAL TYPE	YIELD STRENGTH	GROWTH EQUATION	RETARDATION MODEL	CRITICAL STRESS INTENSITY (SURFACE)	THRESHOLD STRESS INTENSITY (SURFACE)	CRITICAL STRESS INTENSITY (DEPTH)	THRESHOLD STRESS INTENSITY (DEPTH)
1	1.900E 02	1	0	9.000E 01	6.000E 00	9.000E 01	6.000E 00

EQUATION CONSTANTS

CONSTANT NUMBER	MATERIAL TYPE	CRACK GROWTH RATE		RETARDATION MODEL	
		SURFACE	DEPTH	SURFACE	DEPTH
1	1	7.500E-10	7.500E-10	0.0	0.0
2	1	2.740E 00	2.740E 00	0.0	0.0
3	1	9.000E 01	9.000E 01	0.0	0.0
4	1	6.000E 00	6.000E 00	0.0	0.0

PROOF INPUT DATA

PROOF TYPE 1 LOWER A 0.0  
PROOF 1.000E 02 UPPER A 5.000E-01  
KC PROOF 7.000E 01 A/C 3.330E-01  
KA PROOF 9.000E 01 ITERATION LIMIT 100

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FOR QUALITY

RUN 2

USAC ITERATION ON CRACK SIZE / PROOF TEST

CRACK IS A PART THRU CRACK

BLOCK	STEP	CYCLES	HALF SURFACE CRACK LENGTH (IN)	CRACK DEPTH (IN)	KMAX-SURFACE (KSI ROOT-IN)	KMAX-DEPTH (KSI ROOT-IN)	SURFACE GROWTH RATE (IN/CYCLE)	DEPTH GROWTH RATE (IN/CYCLE)
1	1	0.0	2.119E-01	7.057E-02	3.375E 01	6.009E 01	1.187E-05	1.049E-04
1	1	2.500E 01	2.122E-01	7.325E-02	3.461E 01	6.061E 01	1.280E-05	1.100E-04
10	1	0.0	2.161E-01	1.017E-01	4.493E 01	6.584E 01	2.994E-04	1.819E-04
10	1	2.500E 01	2.169E-01	1.064E-01	4.641E 01	6.636E 01	3.366E-05	1.915E-04
20	1	0.0	2.332E-01	1.633E-01	6.346E 01	7.133E 01	1.435E-04	3.343E-04
20	1	2.500E 01	2.371E-01	1.719E-01	6.549E 01	7.204E 01	1.752E-04	3.649E-04

LIMIT LOAD FRACTURE OCCURS IN THE 1 BLOCK 1 STEP AFTER 0.0 CYCLES

CRITICAL K AT DEPTH HAS BEEN EXCEEDED IN THE 26 BLOCK AND THE 1 STEP AFTER 1.289E 01 CYCLES

11111111112222222222333333333344444444445555555555666666666677777777778  
 1234567890123456789012345678901234567890123456789012345678901234567890

1	DAAC	PIN LOADED LUG WITH PLOTTING									
2	1	1000	10	1							
3	1.		0	1	1	1					1 500.
4	1	0 75.									
5	50.	0.			1000.	1					
6	1	11									
7	6.	.5		.1	.1	30.	.5				
15	1										
16	190.	1	C	0 90.	6.	90.	6.				
23	7.5E-10										
23	2.74										
23	90.										
23	6.										END

11111111112222222222333333333344444444445555555555666666666677777777778  
 1234567890123456789012345678901234567890123456789012345678901234567890

Card Type

Column Number

RUN 1 OF 1 RUNS

DAAC PIN LOADED LUG WITH PLOTTING

# LOAD INPUT DATA

STRESS FACTOR 1.000E 00  
LIMIT STRESS 7.500E 01

STEP	MAX STRESS	MIN STRESS	UNITS(CYCLES)	MATERIAL TYPE
------	------------	------------	---------------	---------------

1	5.000E 01	0.0	1.000E 03	1
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# GEOMETRY INPUT DATA

CRACK TYPE PTC - 11  
WIDTH 6.000E 00  
ADDITIONAL DIMENSION 3.000E 01  
RADIUS/NOTCH DEPTH 5.000E-01  
THICKNESS 5.000E-01  
CRACK DEPTH 1.000E-01  
HALF CRACK LENGTH 1.000E-01

# MATERIAL INPUT DATA

MATERIAL TYPE	YIELD STRENGTH	GROWTH EQUATION	RETARDATION MODEL	CRITICAL STRESS INTENSITY (SURFACE)	THRESHOLD STRESS INTENSITY (SURFACE)	CRITICAL STRESS INTENSITY (DEPTH)	THRESHOLD STRESS INTENSITY (DEPTH)
1	1.900E 02	1	0	9.000E 01	6.000E 00	9.000E 01	6.000E 00

-----EQUATION CONSTANTS-----

CONSTANT NUMBER	MATERIAL TYPE	CRACK GROWTH RATE		RETARDATION MODEL	
		SURFACE	DEPTH	SURFACE	DEPTH
1	1	7.500E-10	7.500E-10	0.0	0.0
2	1	2.740E 00	2.740E 00	0.0	0.0
3	1	9.000E 01	9.000E 01	0.0	0.0
4	1	6.000E 00	6.000E 00	0.0	0.0

RUN 1

D6AC PIN LOADED LUG WITH PLOTTING

CRACK IS A PART THRU CRACK

BLOCK	STEP	CYCLES	HALF SURFACE CRACK LENGTH (IN)	CRACK DEPTH (IN)	KMAX=SURFACE (KSI ROOT-IN)	KMAX=DEPTH (KSI ROOT-IN)	SURFACE GROWTH RATE (IN/CYCLE)	DEPTH GROWTH RATE (IN/CYCLE)
1	1	0.0	1.000E-01	1.000E-01	3.205E 01	3.690E 01	1.020E-05	1.555E-05
1	1	1.000E 03	1.102E-01	1.158E-01	3.207E 01	3.727E 01	1.021E-05	1.605E-05

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RUN 1

D6AC PIN LOADED LIG WITH PLOTTING

CRACK IS A CRACK IN TRANSITION

BLOCK	STEP	CYCLES	HALF FRONT CRACK LENGTH (IN)	HALF BACK CRACK LENGTH (IN)	KMAX=FRONT (KSI ROOT-IN)	KMAX=BACK (KSI ROOT-IN)	FRONT GROWTH RATE (IN/CYCLE)	BACK GROWTH RATE (IN/CYCLE)
0	1	7.066E-02	1.885E-01	1.769E-01	5.532E-01	8.864E-01	6.946E-05	6.166E-02

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RUN 1 06AC PIN LOADED LIG WITH PLOTTING

CRACK IS A THROUGH CRACK

BLOCK	STEP	CYCLES	HALF CRACK LENGTH (IN)	KMAX (KSI ROOT-IN)	CRACK GROWTH RATE (IN/CYCLE)
9	1	3.184E 02	1.963E-01	5.543E 01	7.008E-05
9	1	1.000E 03	2.091E-01	5.545E 01	7.020E-05
10	1	0.0	2.091E-01	5.545E 01	7.020E-05
10	1	1.000E 03	2.797E-01	5.559E 01	7.105E-05
20	1	0.0	1.227E 00	6.955E 01	2.707E-04

LIMIT LOAD FRACTURE OCCURS IN THE 9 BLOCK 1 STEP AFTER 4.085E 02 CYCLES

CRITICAL K AT SURFACE HAS BEEN EXCEEDED IN THE 20 BLOCK AND THE 1 STEP AFTER 7.241E 02 CYCLES

TITLE D6AC PIN LOADED LUG WITH PLOTTING 1.000E 03

DATA 1.000E-01 1.000E-01 0.0  
 DATA 1.094E-01 1.061E-01 5.285E 02  
 DATA 1.157E-01 1.102E-01 1.000E 03  
 DATA 1.254E-01 1.163E-01 1.516E 03  
 DATA 1.321E-01 1.204E-01 2.000E 03  
 DATA 1.430E-01 1.271E-01 2.573E 03  
 DATA 1.488E-01 1.306E-01 3.000E 03  
 DATA 1.595E-01 1.371E-01 3.536E 03  
 DATA 1.659E-01 1.409E-01 4.000E 03  
 DATA 1.779E-01 1.479E-01 4.588E 03  
 DATA 1.833E-01 1.511E-01 5.000E 03  
 DATA 1.946E-01 1.576E-01 5.530E 03  
 DATA 2.010E-01 1.613E-01 6.000E 03  
 DATA 2.134E-01 1.653E-01 6.573E 03  
 DATA 2.190E-01 1.714E-01 7.000E 03  
 DATA 2.324E-01 1.789E-01 7.617E 03  
 DATA 2.371E-01 1.815E-01 8.000E 03  
 DATA 2.492E-01 1.881E-01 8.527E 03  
 DATA 2.525E-01 2.091E-01 9.000E 03  
 DATA 2.525E-01 2.476E-01 9.513E 03  
 DATA 2.525E-01 2.797E-01 1.000E 04  
 DATA 2.525E-01 3.215E-01 1.054E 04  
 DATA 2.525E-01 3.514E-01 1.100E 04  
 DATA 2.525E-01 3.920E-01 1.150E 04  
 DATA 2.525E-01 4.252E-01 1.200E 04  
 DATA 2.525E-01 4.697E-01 1.252E 04  
 DATA 2.525E-01 5.024E-01 1.300E 04  
 DATA 2.525E-01 5.494E-01 1.352E 04  
 DATA 2.525E-01 5.844E-01 1.400E 04  
 DATA 2.525E-01 6.391E-01 1.456E 04  
 DATA 2.525E-01 6.732E-01 1.500E 04  
 DATA 2.525E-01 7.289E-01 1.551E 04  
 DATA 2.525E-01 7.719E-01 1.600E 04  
 DATA 2.525E-01 8.354E-01 1.651E 04  
 DATA 2.525E-01 8.858E-01 1.700E 04  
 DATA 2.525E-01 9.688E-01 1.755E 04  
 DATA 2.525E-01 1.027E 00 1.800E 04  
 DATA 2.525E-01 1.134E 00 1.854E 04  
 DATA 2.525E-01 1.227E 00 1.900E 04  
 DATA 2.525E-01 1.425E 00 1.951E 04  
 DATA 2.525E-01 1.739E 00 1.972E 04

MDR5

MDR1 CRITICAL \* AT SURFACE EXCEEDED

MDR2 20 BLOCK 1 STEP 7.241E 02 CYCLE

MDR3 TOTAL CYCLES \* 1.972E 04

MDR4

MDR5

MDR6

B-34

## 1. TABULAR INPUT EXAMPLES

11111111122222222233333333344444444455555555566666666677777777778  
1234567890123456789012345678901234567890123456789012345678901234567890

Column Number

**B-35**

ORIGINAL PAGE IS  
OF POOR QUALITY

1234567890123456789012345678901234567890123456789012345678901234567890

[illegible]

1234567890123456789012345678901234567890123456789012345678901234567890

Column Number

11111111112222222222333333333344444444445555555555666666666677777777778  
 12345678901234567890123456789012345678901234567890123456789012345678901234567890

12.8							
121.2							
121.6							
122.							
124.							
1220.							END
130.							
13.1							
13.2							
13.3							
13.4						Run 3	
13.48							
13.5							END
141.1	1.1	1.1	1.2	1.3	2.	100.	
141.1	1.1	1.2	1.3	1.4	2.4	120.	
141.1	1.1	1.2	1.4	1.6	3.	160.	
141.3	1.3	1.4	1.5	1.8	4.	180.	
141.7	1.7	1.9	2.2	2.5	5.	200.	
142.	2.	2.5	3.	5.	6.	250.	
144.	4.	6.	8.	10.	15.	300.	
1410.	10.	15.	20.	30.	40.	350.	
14100.	100.	200.	300.	350.	400.	400.	

11111111112222222222333333333344444444445555555555666666666677777777778  
 12345678901234567890123456789012345678901234567890123456789012345678901234567890

Card Type

Column Number

RUN 1 OF 3 RUNS

TABULAR INPUT EXAMPLES

LOAD INPUT DATA

STRESS FACTOR 1.000E 00  
LIMIT STRESS 1.800E 02

STEP MAX STRESS MIN STRESS UNITS(CYCLES) MATERIAL TYPE

1 1.200E 02 0.0 2.500E 01 1

GEOMETRY INPUT DATA

CRACK TYPE PTC - 1  
WIDTH 9.900E 01  
ADDITIONAL DIMENSION 0.0  
RADIUS/NOTCH DEPTH 0.0  
THICKNESS 5.000E-01  
CRACK DEPTH 5.000E-02  
HALF CRACK LENGTH 7.500E-02

MATERIAL INPUT DATA

MATERIAL TYPE	YIELD STRENGTH	GROWTH EQUATION	RETARDATION MODEL	CRITICAL STRESS INTENSITY (SURFACE)	THRESHOLD STRESS INTENSITY (SURFACE)	CRITICAL STRESS INTENSITY (DEPTH)	THRESHOLD STRESS INTENSITY (DEPTH)
1	1.900E 02	4	0	9.000E 01	6.000E 00	9.000E 01	6.000E 00

MATERIAL TYPE 1 TABLE 7

RE=	0.0	3.000E-01	5.000E-01	1.000E 00
DKE= 6.000E 00	1.000E-13	3.000E-13	4.000E-13	4.000E-13
DKE= 8.000E 00	1.000E-09	3.000E-09	4.000E-09	4.000E-09
DKE= 1.000E 01	1.000E-08	3.000E-08	4.000E-08	4.000E-08
DKE= 1.200E 01	1.000E-07	3.000E-07	4.000E-07	4.000E-07
DKE= 1.600E 01	2.400E-06	7.200E-06	1.000E-05	1.000E-05
DKE= 3.000E 01	9.000E-06	2.700E-05	4.000E-05	4.000E-05
DKE= 8.400E 01	5.000E-05	1.500E-04	2.000E-04	2.000E-04
DKE= 9.000E 01	1.000E-02	3.000E-02	4.000E-02	4.000E-02

MATERIAL TYPE 1 TABLE 8

RE=	0.0	3.000E-01	5.000E-01	1.000E 00
DKE= 6.000E 00	1.000E-13	3.000E-13	4.000E-13	4.000E-13
DKE= 8.000E 00	1.000E-09	3.000E-09	4.000E-09	4.000E-09
DKE= 1.000E 01	1.000E-08	3.000E-08	4.000E-08	4.000E-08
DKE= 1.200E 01	1.000E-07	3.000E-07	4.000E-07	4.000E-07
DKE= 1.600E 01	2.400E-06	7.200E-06	1.000E-05	1.000E-05
DKE= 3.000E 01	9.000E-06	2.700E-05	4.000E-05	4.000E-05
DKE= 8.400E 01	5.000E-05	1.500E-04	2.000E-04	2.000E-04
DKE= 9.000E 01	1.000E-02	3.000E-02	4.000E-02	4.000E-02

RUN 1

## TABULAR INPUT EXAMPLES

CRACK IS A PART THRU CRACK

BLOCK	STEP	CYCLES	HALF SURFACE CRACK LENGTH (IN)	CRACK DEPTH (IN)	KMAX-SURFACE (KSI ROOT-IN)	KMAX-DEPTH (KSI ROOT-IN)	SURFACE GROWTH RATE (IN/CYCLE)	DEPTH GROWTH RATE (IN/CYCLE)
1	1	0.0	7.500E-02	5.000E-02	3.477E 01	4.007E 01	1.151E-05	1.457E-05
1	1	2.500E 01	7.529E-02	5.036E-02	3.477E 01	4.007E 01	1.151E-05	1.457E-05
10	1	0.0	7.766E-02	5.332E-02	3.612E 01	4.080E 01	1.226E-05	1.502E-05
10	1	2.500E 01	7.797E-02	5.370E-02	3.612E 01	4.080E 01	1.226E-05	1.502E-05
20	1	0.0	8.082E-02	5.713E-02	3.761E 01	4.162E 01	1.312E-05	1.553E-05
20	1	2.500E 01	8.115E-02	5.752E-02	3.761E 01	4.162E 01	1.312E-05	1.553E-05
30	1	0.0	8.420E-02	6.108E-02	3.908E 01	4.253E 01	1.398E-05	1.610E-05
30	1	2.500E 01	8.455E-02	6.148E-02	3.908E 01	4.253E 01	1.398E-05	1.610E-05
40	1	0.0	8.779E-02	6.517E-02	4.054E 01	4.353E 01	1.486E-05	1.673E-05
40	1	2.500E 01	8.817E-02	6.559E-02	4.054E 01	4.353E 01	1.486E-05	1.673E-05
50	1	0.0	9.161E-02	6.943E-02	4.200E 01	4.455E 01	1.576E-05	1.739E-05
50	1	2.500E 01	9.200E-02	6.986E-02	4.200E 01	4.455E 01	1.576E-05	1.739E-05
60	1	0.0	9.565E-02	7.385E-02	4.346E 01	4.558E 01	1.669E-05	1.806E-05
60	1	2.500E 01	9.607E-02	7.430E-02	4.346E 01	4.558E 01	1.669E-05	1.806E-05
70	1	0.0	9.993E-02	7.843E-02	4.488E 01	4.656E 01	1.761E-05	1.871E-05
70	1	2.500E 01	1.004E-01	7.890E-02	4.488E 01	4.656E 01	1.761E-05	1.871E-05
80	1	0.0	1.044E-01	8.319E-02	4.631E 01	4.756E 01	1.855E-05	1.939E-05
80	1	2.500E 01	1.049E-01	8.367E-02	4.631E 01	4.756E 01	1.855E-05	1.939E-05
90	1	0.0	1.092E-01	8.811E-02	4.774E 01	4.859E 01	1.951E-05	2.009E-05
90	1	2.500E 01	1.097E-01	8.861E-02	4.774E 01	4.859E 01	1.951E-05	2.009E-05
100	1	0.0	1.142E-01	9.322E-02	4.917E 01	4.965E 01	2.050E-05	2.083E-05
100	1	2.500E 01	1.147E-01	9.374E-02	4.917E 01	4.965E 01	2.050E-05	2.083E-05
110	1	0.0	1.194E-01	9.851E-02	5.062E 01	5.074E 01	2.151E-05	2.160E-05
110	1	2.500E 01	1.199E-01	9.905E-02	5.062E 01	5.074E 01	2.151E-05	2.160E-05
120	1	0.0	1.249E-01	1.040E-01	5.207E 01	5.186E 01	2.255E-05	2.239E-05
120	1	2.500E 01	1.255E-01	1.046E-01	5.207E 01	5.186E 01	2.255E-05	2.239E-05
130	1	0.0	1.307E-01	1.097E-01	5.353E 01	5.301E 01	2.361E-05	2.323E-05
130	1	2.500E 01	1.312E-01	1.103E-01	5.353E 01	5.301E 01	2.361E-05	2.323E-05
140	1	0.0	1.367E-01	1.156E-01	5.501E 01	5.419E 01	2.470E-05	2.410E-05
140	1	2.500E 01	1.373E-01	1.162E-01	5.501E 01	5.419E 01	2.470E-05	2.410E-05
150	1	0.0	1.430E-01	1.217E-01	5.650E 01	5.540E 01	2.583E-05	2.500E-05
150	1	2.500E 01	1.436E-01	1.223E-01	5.650E 01	5.540E 01	2.583E-05	2.500E-05
160	1	0.0	1.496E-01	1.281E-01	5.800E 01	5.665E 01	2.698E-05	2.594E-05
160	1	2.500E 01	1.502E-01	1.287E-01	5.800E 01	5.665E 01	2.698E-05	2.594E-05
170	1	0.0	1.564E-01	1.347E-01	5.951E 01	5.796E 01	2.816E-05	2.695E-05
170	1	2.500E 01	1.571E-01	1.353E-01	5.951E 01	5.796E 01	2.816E-05	2.695E-05
180	1	0.0	1.636E-01	1.415E-01	6.104E 01	5.929E 01	2.938E-05	2.799E-05
180	1	2.500E 01	1.644E-01	1.422E-01	6.104E 01	5.929E 01	2.938E-05	2.799E-05
190	1	0.0	1.711E-01	1.486E-01	6.259E 01	6.066E 01	3.063E-05	2.908E-05
190	1	2.500E 01	1.719E-01	1.494E-01	6.259E 01	6.066E 01	3.063E-05	2.908E-05
200	1	0.0	1.789E-01	1.560E-01	6.416E 01	6.207E 01	3.192E-05	3.021E-05
200	1	2.500E 01	1.797E-01	1.568E-01	6.416E 01	6.207E 01	3.192E-05	3.021E-05
210	1	0.0	1.870E-01	1.637E-01	6.575E 01	6.351E 01	3.325E-05	3.138E-05
210	1	2.500E 01	1.879E-01	1.645E-01	6.575E 01	6.351E 01	3.325E-05	3.138E-05
220	1	0.0	1.955E-01	1.717E-01	6.736E 01	6.499E 01	3.462E-05	3.261E-05
220	1	2.500E 01	1.964E-01	1.725E-01	6.736E 01	6.499E 01	3.462E-05	3.261E-05
230	1	0.0	2.043E-01	1.800E-01	6.900E 01	6.650E 01	3.603E-05	3.389E-05
230	1	2.500E 01	2.052E-01	1.808E-01	6.900E 01	6.650E 01	3.603E-05	3.389E-05
240	1	0.0	2.135E-01	1.886E-01	7.065E 01	6.806E 01	3.748E-05	3.522E-05
240	1	2.500E 01	2.144E-01	1.895E-01	7.065E 01	6.806E 01	3.748E-05	3.522E-05
250	1	0.0	2.230E-01	1.976E-01	7.234E 01	6.966E 01	3.898E-05	3.661E-05
250	1	2.500E 01	2.240E-01	1.985E-01	7.234E 01	6.966E 01	3.898E-05	3.661E-05
260	1	0.0	2.329E-01	2.069E-01	7.405E 01	7.131E 01	4.053E-05	3.816E-05



260	1	2.500F 01	2.339E-01	2.078E-01	7.405E 01	7.131E 01	4.053E-05	3.806E-05
270	1	0.0	2.432E-01	2.166E-01	7.578E 01	7.301E 01	4.212E-05	3.950E-05
270	1	2.500E 01	2.443E-01	2.176E-01	7.578E 01	7.301E 01	4.212E-05	3.950E-05
280	1	0.0	2.540E-01	2.266E-01	7.755E 01	7.475E 01	4.377E-05	4.117E-05
280	1	2.500F 01	2.551E-01	2.277E-01	7.755E 01	7.475E 01	4.377E-05	4.117E-05
290	1	0.0	2.651E-01	2.371E-01	7.934E 01	7.656E 01	4.547E-05	4.284E-05
290	1	2.500E 01	2.662E-01	2.382E-01	7.934E 01	7.656E 01	4.547E-05	4.284E-05
300	1	0.0	2.767E-01	2.480E-01	8.117E 01	7.842E 01	4.723E-05	4.459E-05
300	1	2.500E 01	2.778E-01	2.491E-01	8.117E 01	7.842E 01	4.723E-05	4.459E-05
310	1	0.0	2.887E-01	2.594E-01	8.303E 01	8.035E 01	4.904E-05	4.644E-05
310	1	2.500F 01	2.899E-01	2.605E-01	8.303E 01	8.035E 01	4.904E-05	4.644E-05
320	1	0.0	3.036E-01	2.712E-01	8.484E 01	8.276E 01	1.076E-04	4.878E-05
320	1	2.500E 01	3.063E-01	2.724E-01	8.484E 01	8.276E 01	1.076E-04	4.878E-05

LIMIT LOAD FRACTURE OCCURS IN THE 173 BLOCK 1 STEP AFTER 0.0 CYCLES

CRITICAL K AT DEPTH HAS BEEN EXCEEDED IN THE 326 BLOCK AND THE 1 STEP AFTER 1.233E 01 CYCLES

RUN 2 OF 3 RUNS

# TABULAR INPUT EXAMPLES

## LOAD INPUT DATA

STRESS FACTOR 1.000E 00  
LIMIT STRESS 1.000E 02

STEP MAX STRESS MIN STRESS UNITS(CYCLES) MATERIAL TYPE

1 1.200E 02 0.0 2.500E 01 1

## GEOMETRY INPUT DATA

CRACK TYPE TC - 7  
WIDTH 9.900E 01  
ADDITIONAL DIMENSION 0.0  
RADIUS/NOTCH DEPTH 0.0  
THICKNESS 5.000E-01  
HALF CRACK LENGTH 7.500E-02

TABLE 1: BETA C

	A= 0.0	1.000E 00
C= 0.0	1.000E 00	1.000E 00
C= 1.000E 00	1.000E 00	1.000E 00
C= 1.200E 00	9.000E-01	9.000E-01
C= 1.500E 00	7.000E-01	7.000E-01
C= 1.700E 00	6.500E-01	6.500E-01
C= 1.800E 00	7.000E-01	7.000E-01
C= 2.000E 00	8.000E-01	8.000E-01
C= 3.000E 00	1.100E 00	1.100E 00
C= 1.000E 02	1.100E 00	1.100E 00

TABLE 2: BETA A

	A= 0.0
C= 0.0	0.0

TABLE 3: BETA C

	A= 0.0	1.000E 00
C= 0.0	1.000E 00	1.000E 00
C= 1.000E 00	1.000E 00	1.000E 00
C= 1.200E 00	1.200E 00	1.200E 00
C= 1.500E 00	2.000E 00	2.000E 00
C= 1.700E 00	3.000E 00	3.000E 00
C= 1.800E 00	1.000E 01	1.000E 01
C= 2.000E 00	1.000E 15	1.000E 15
C= 3.000E 00	1.000E 15	1.000E 15
C= 1.000E 02	1.000E 15	1.000E 15

TABLE 4: BETA A

	A= 0.0
C= 0.0	0.0

## MATERIAL INPUT DATA

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MATERIAL TYPE	YIELD STRENGTH	GROWTH EQUATION	RETARDATION MODEL	CRITICAL STRESS INTENSITY (SURFACE)	THRESHOLD STRESS INTENSITY (SURFACE)	CRITICAL STRESS INTENSITY (DEPTH)	THRESHOLD STRESS INTENSITY (DEPTH)
1	1.900E 02	4	0	9.000E 01	6.000E 00	9.000E 01	6.000E 00

MATERIAL TYPE 1 TABLE 7

	RE= 0.0	3.000E-01	5.000E-01	1.000E 00
DKE= 6.000E 00	1.000E-13	3.000E-13	4.000E-13	4.000E-13
DKE= 8.000E 00	1.000E-09	3.000E-09	4.000E-09	4.000E-09
DKE= 1.000E 01	1.000E-08	3.000E-08	4.000E-08	4.000E-08
DKE= 1.200E 01	1.000E-07	3.000E-07	4.000E-07	4.000E-07
DKE= 1.600E 01	2.400E-06	7.200E-06	1.000E-05	1.000E-05
DKE= 3.000E 01	9.000E-06	2.700E-05	4.000E-05	4.000E-05
DKE= 8.400E 01	5.000E-05	1.500E-04	2.000E-04	2.000E-04
DKE= 9.000E 01	1.000E-02	3.000E-02	4.000E-02	4.000E-02

MATERIAL TYPE 1 TABLE 8

	RE= 0.0	3.000E-01	5.000E-01	1.000E 00
DKE= 6.000E 00	1.000E-13	3.000E-13	4.000E-13	4.000E-13
DKE= 8.000E 00	1.000E-09	3.000E-09	4.000E-09	4.000E-09
DKE= 1.000E 01	1.000E-08	3.000E-08	4.000E-08	4.000E-08
DKE= 1.200E 01	1.000E-07	3.000E-07	4.000E-07	4.000E-07
DKE= 1.600E 01	2.400E-06	7.200E-06	1.000E-05	1.000E-05
DKE= 3.000E 01	9.000E-06	2.700E-05	4.000E-05	4.000E-05
DKE= 8.400E 01	5.000E-05	1.500E-04	2.000E-04	2.000E-04
DKE= 9.000E 01	1.000E-02	3.000E-02	4.000E-02	4.000E-02

RUN 2

TABULAR INPUT EXAMPLES

CRACK IS A THROUGH CRACK

BLOCK	STEP	CYCLES	HALF CRACK LENGTH (IN)	KMAX (KSI ROOT-IN)	CRACK GROWTH RATE (IN/CYCLE)
1	1	0.0	7.500E-02	5.839E 01	2.729E-05
1	1	2.500E 01	7.568E-02	5.839E 01	2.729E-05
10	1	0.0	8.133E-02	6.081E 01	2.919E-05
10	1	2.500E 01	8.206E-02	6.081E 01	2.919E-05
20	1	0.0	8.887E-02	6.357E 01	3.143E-05
20	1	2.500E 01	8.966E-02	6.357E 01	3.143E-05
30	1	0.0	9.699E-02	6.641E 01	3.380E-05
30	1	2.500E 01	9.784E-02	6.641E 01	3.380E-05
40	1	0.0	1.057E-01	6.933E 01	3.632E-05
40	1	2.500E 01	1.066E-01	6.933E 01	3.632E-05
50	1	0.0	1.151E-01	7.234E 01	3.898E-05
50	1	2.500E 01	1.161E-01	7.234E 01	3.898E-05
60	1	0.0	1.252E-01	7.543E 01	4.180E-05
60	1	2.500E 01	1.262E-01	7.543E 01	4.180E-05
70	1	0.0	1.359E-01	7.862E 01	4.478E-05
70	1	2.500E 01	1.371E-01	7.862E 01	4.478E-05
80	1	0.0	1.475E-01	8.189E 01	4.792E-05
80	1	2.500E 01	1.487E-01	8.189E 01	4.792E-05
90	1	0.0	1.674E-01	8.724E 01	9.142E-04

LIMIT LOAD FRACTURE OCCURS IN THE 7 BLOCK 1 STEP AFTER 0.0 CYCLES

CRITICAL K AT SURFACE HAS BEEN EXCEEDED IN THE 90 BLOCK AND THE 1 STEP AFTER 5.458E 00 CYCLES

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OF POOR QUALITY

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## LOAD INPUT DATA

STRESS FACTOR 1.000E 00  
LIMIT STRESS 1.000E 02

STEP MAX STRESS MIN STRESS UNITS(CYCLES) MATERIAL TYPE

1 1.200E 02 0.0 2.500E 01 1

## GEOMETRY INPUT DATA

CRACK TYPE PTC - 7  
WIDTH 9.900E 01  
ADDITIONAL DIMENSION 0.0  
RADIUS/NOTCH DEPTH 0.0  
THICKNESS 5.000E-01  
CRACK DEPTH 5.000E-02  
HALF CRACK LENGTH 7.500E-02

TABLE 1: BETA C

A= 0.0		1.000E-01	2.000E-01	3.000E-01	4.000E-01	4.800E-01	5.000E-01
C= 0.0	1.000E 00	1.000E 00	1.100E 00	1.200E 00	1.300E 00	2.000E 00	1.600E 02
C= 1.000E-01	1.000E 00	1.000E 00	1.200E 00	1.300E 00	1.400E 00	2.400E 00	1.200E 02
C= 2.000E-01	1.100E 00	1.100E 00	1.200E 00	1.400E 00	1.600E 00	3.000E 00	1.400E 02
C= 4.000E-01	1.300E 00	1.300E 00	1.400E 00	1.500E 00	1.800E 00	4.000E 00	1.800E 02
C= 6.000E-01	1.700E 00	1.700E 00	1.900E 00	2.200E 00	2.500E 00	5.000E 00	2.000E 02
C= 8.000E-01	2.000E 00	2.000E 00	2.500E 00	3.000E 00	5.000E 00	6.000E 00	2.500E 02
C= 1.000E 00	4.000E 00	4.000E 00	6.000E 00	8.000E 00	1.000E 01	1.500E 01	3.000E 02
C= 2.000E 00	1.000E 01	1.000E 01	1.500E 01	2.000E 01	3.000E 01	4.000E 01	3.500E 02
C= 1.000E 01	1.000E 02	1.000E 02	2.000E 02	3.000E 02	3.500E 02	4.000E 02	4.000E 02

TABLE 2: BETA A

A= 0.0		1.000E-01	2.000E-01	3.000E-01	4.000E-01	4.800E-01	5.000E-01
C= 0.0	1.100E 00	1.100E 00	1.100E 00	1.200E 00	1.300E 00	2.000E 00	1.000E 02
C= 1.000E-01	1.100E 00	1.100E 00	1.200E 00	1.300E 00	1.400E 00	2.400E 00	1.200E 02
C= 2.000E-01	1.100E 00	1.100E 00	1.200E 00	1.400E 00	1.600E 00	3.000E 00	1.400E 02
C= 4.000E-01	1.300E 00	1.300E 00	1.400E 00	1.500E 00	1.800E 00	4.000E 00	1.800E 02
C= 6.000E-01	1.700E 00	1.700E 00	1.900E 00	2.200E 00	2.500E 00	5.000E 00	2.000E 02
C= 8.000E-01	2.000E 00	2.000E 00	2.500E 00	3.000E 00	5.000E 00	6.000E 00	2.500E 02
C= 1.000E 00	4.000E 00	4.000E 00	6.000E 00	8.000E 00	1.000E 01	1.500E 01	3.000E 02
C= 2.000E 00	1.000E 01	1.000E 01	1.500E 01	2.000E 01	3.000E 01	4.000E 01	3.500E 02
C= 1.000E 01	1.000E 02	1.000E 02	2.000E 02	3.000E 02	3.500E 02	4.000E 02	4.000E 02

## MATERIAL INPUT DATA

MATERIAL TYPE	YIELD STRENGTH	GROWTH EQUATION	RETARDATION MODEL	CRITICAL STRESS INTENSITY (SURFACE)	THRESHOLD STRESS INTENSITY (SURFACE)	CRITICAL STRESS INTENSITY (DEPTH)	THRESHOLD STRESS INTENSITY (DEPTH)
1	1.900E 02	4	0	9.000E 01	6.000E 00	9.000E 01	6.000E 00
MATERIAL TYPE 1 TABLE 7							
RE= 0.0		3.000E-01	5.000E-01	1.000E 00			

DKE= 6.000E 00	1.000E-13	3.000E-13	4.000E-13	4.000E-13
DKE= 8.000E 00	1.000E-09	3.000E-09	4.000E-09	4.000E-09
DKE= 1.000E 01	1.000E-08	3.000E-08	4.000E-08	4.000E-08
DKE= 1.200E 01	1.000E-07	3.000E-07	4.000E-07	4.000E-07
DKE= 1.600E 01	2.400E-06	7.200E-06	1.000E-05	1.000E-05
DKE= 3.000E 01	9.000E-06	2.700E-05	4.000E-05	4.000E-05
DKE= 8.400E 01	5.000E-05	1.500E-04	2.000E-04	2.000E-04
DKE= 9.000E 01	1.000E-02	3.000E-02	4.000E-02	4.000E-02

MATERIAL TYPE 1 TABLE 8

	RE= 0.0	3.000E-01	5.000E-01	1.000E 00
DKE= 6.000E 00	1.000E-13	3.000E-13	4.000E-13	4.000E-13
DKE= 8.000E 00	1.000E-09	3.000E-09	4.000E-09	4.000E-09
DKE= 1.000E 01	1.000E-08	3.000E-08	4.000E-08	4.000E-08
DKE= 1.200E 01	1.000E-07	3.000E-07	4.000E-07	4.000E-07
DKE= 1.600E 01	2.400E-06	7.200E-06	1.000E-05	1.000E-05
DKE= 3.000E 01	9.000E-06	2.700E-05	4.000E-05	4.000E-05
DKE= 8.400E 01	5.000E-05	1.500E-04	2.000E-04	2.000E-04
DKE= 9.000E 01	1.000E-02	3.000E-02	4.000E-02	4.000E-02

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ORIGINAL PAGE IS  
OF POOR QUALITY

RUN 2

TABULAR INPUT EXAMPLES

CRACK IS A PART THRU CRACK

BLOCK	STEP	CYCLES	HALF SURFACE CRACK LENGTH (IN)	CRACK DEPTH (IN)	KMAX-SURFACE (KSI ROOT-IN)	KMAX-DEPTH (KSI ROOT-IN)	SURFACE GROWTH RATE (IN/CYCLE)	DEPTH GROWTH RATE (IN/CYCLE)
1	1	0.0	7.500E-02	5.000E-02	4.768E 01	5.245E 01	1.947E-05	2.282E-05
1	1	2.500E 01	7.549E-02	5.057E-02	4.792E 01	5.271E 01	1.963E-05	2.301E-05
10	1	0.0	7.955E-02	5.534E-02	5.016E 01	5.517E 01	2.118E-05	2.483E-05
10	1	2.500E 01	8.008E-02	5.596E-02	5.041E 01	5.545E 01	2.136E-05	2.504E-05
20	1	0.0	8.508E-02	6.182E-02	5.301E 01	5.832E 01	2.323E-05	2.723E-05
20	1	2.500E 01	8.566E-02	6.250E-02	5.328E 01	5.861E 01	2.342E-05	2.745E-05
30	1	0.0	9.114E-02	6.891E-02	5.597E 01	6.157E 01	2.543E-05	2.981E-05
30	1	2.500E 01	9.177E-02	6.966E-02	5.625E 01	6.188E 01	2.564E-05	3.005E-05
40	1	0.0	9.776E-02	7.667E-02	5.904E 01	6.495E 01	2.779E-05	3.258E-05
40	1	2.500E 01	9.846E-02	7.749E-02	5.934E 01	6.527E 01	2.803E-05	3.285E-05
50	1	0.0	1.050E-01	8.515E-02	6.253E 01	6.844E 01	3.058E-05	3.555E-05
50	1	2.500E 01	1.058E-01	8.604E-02	6.289E 01	6.878E 01	3.088E-05	3.584E-05
60	1	0.0	1.130E-01	9.439E-02	6.636E 01	7.206E 01	3.377E-05	3.873E-05
60	1	2.500E 01	1.139E-01	9.536E-02	6.675E 01	7.242E 01	3.409E-05	3.905E-05
70	1	0.0	1.219E-01	1.045E-01	7.103E 01	7.602E 01	3.782E-05	4.234E-05
70	1	2.500E 01	1.228E-01	1.055E-01	7.158E 01	7.644E 01	3.830E-05	4.273E-05
80	1	0.0	1.319E-01	1.155E-01	7.673E 01	8.048E 01	4.301E-05	4.656E-05
80	1	2.500E 01	1.330E-01	1.167E-01	7.733E 01	8.095E 01	4.356E-05	4.701E-05
90	1	0.0	1.439E-01	1.372E-01	8.713E 01	8.904E 01	8.275E-04	4.377E-03

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LIMIT LOAD FRACTURE OCCURS IN THE 24 BLOCK 1 STEP AFTER 2.287E 01 CYCLES

CRITICAL K AT DEPTH HAS BEEN EXCEEDED IN THE 90 BLOCK AND THE 1 STEP AFTER 5.148E-01 CYCLES

APPENDIX C  
STRESS INTENSITY FACTORS  
Through Cracks\*

Center crack

$$K_c = \sigma_g \sqrt{\pi c \sec \frac{\pi c}{W}} \quad (\text{Ref. C-1})$$

Compact specimen, ASTM E399-74,

$$K_c = \frac{P}{t h W} \left[ 29.6 \left( \frac{c}{W} \right)^{1/2} - 185.5 \left( \frac{c}{W} \right)^{3/2} + 655.7 \left( \frac{c}{W} \right)^{5/2} - 1017.0 \left( \frac{c}{W} \right)^{7/2} + 6.38.9 \left( \frac{c}{W} \right)^{7/2} \right] \quad (\text{Ref. C-2})$$

Single through crack at hole.

$$\begin{aligned} K_c &= \sigma_g F_b F_w \sqrt{\pi c} \\ F_b &= e^{(1.2133 - 2.205 s + .6451 s^2)} \\ s &= c / (\text{Rad} + c) \\ F_w &= \sqrt{\sec \left( \pi \frac{c + 2 \text{ Rad}}{2(W - c)} \right)} \end{aligned}$$

$F_b$  is an equation which fits Bowie's (Ref.C-3) numerical data for the effect of the hole.  $F_w$  is a modification of Feddersen's (RefC-1) equation to account for the affect of finite width. The distance  $(W-c)$  is twice the distance from the closest edge to the midpoint of the hole and crack length. The effective half crack length in  $F_w$  is  $(\frac{c+2 \text{ Rad}}{2})$ .

\* See Figure 3 for geometry definitions.



Double through crack at hole.

$$K_c = \sigma_g F_b F_w \sqrt{\pi c}$$

$$F_b = e^{(1.2133 - 2.086 + .8727 S^2)}$$

$$S = D / (Rad + C)$$

$$F_w = \sqrt{\sec \frac{\pi(c+Rad)}{W}}$$

$F_b$  is an equation which fits Bowie's (Ref.C-3) numerical data for the effect of the hole.  $F_w$  is a modification to Feddersen's (Ref.C-1) equation to account for the affect of finite width.  $(c+Rad)$  is used as an equivalent half crack length in  $F_w$ .

General tabular description

$$K_c = P F(c) \sqrt{\pi c}$$

$F(c)$  is tabular input data.

$P$  is applied load compatible with  $F(c)$

Since numerical data may be generated by using a number of solutions (e.g., effect of hole and effect of width), the program has the capability of combining a number of tables to generate  $F(c)$ . As many as three tables  $F1(c)$ ,  $F2(c)$ ,  $F3(c)$  may be input and  $F(c)$  is set equal to the interpolated value of

$$F(c) = F1(c) \times F2(c) \times F3(c)$$

The format for the stress intensity factor table is:

F1	F2	F3
c(1,1) F(1,1)	c(2,1) F(2,1)	c(3,1) F(3,1)
c(1,2) F(1,2)	c(2,2) F(2,2)	c(3,2) F(3,3)
.	.	.
.	.	.
.	.	.
c(1,l <sub>1</sub> ) F(1,l <sub>1</sub> )	c(2,l <sub>2</sub> ) F(2,l <sub>2</sub> )	c(3,l <sub>3</sub> ) F(3,l <sub>3</sub> )

If only one table is read in,  $F2 \equiv F3 \equiv 1$ .  $l_1$  and  $l_2$  and  $l_3$  must be  $\leq 25$ .

Pin loaded lug - two through cracks

$$K_c = \left[ \frac{P}{2th} \frac{1.05}{\sqrt{\pi Z}} \times \phi_p + \frac{\sqrt{\pi c}}{W} \phi_\sigma \right]$$

$$\phi_\sigma = \frac{1}{2} [\phi_{\sigma,c} + \phi_{\sigma,s}] \times F_B$$

$$F_B = e^{(1.2133 - 2.086 \times S + .8727 \times S^2)}$$

$$S = c/\text{Rad} + C$$

$$\phi_{\sigma,s} = \sqrt{\sec \frac{\pi Z}{W}} f3(Z/H) \quad (\text{see Table C1})$$

$$\phi_{\sigma,c} = \frac{1}{\sqrt{1 - \frac{2Z}{W}}} \times f2(Z/b) \quad (\text{see Table C1})$$

$$\phi_p = \frac{1}{2} [\phi_{p,c} + \phi_{p,w} \phi_{p,h}]$$

$$\phi_{p,h} = 1 - .08 \left( \frac{2Z}{H} \right) + 2.69 \left( \frac{2Z}{H} \right) - .91 \left( \frac{2Z}{H} \right)^3$$

$$\phi_{p,w} = \frac{1}{\sqrt{1 - \frac{2Z}{W}}} \left[ 1 - .5 \left( \frac{2Z}{W} \right) + .957 \left( \frac{2Z}{W} \right)^2 - .16 \left( \frac{2Z}{W} \right)^3 \right]$$

$$\phi_{p,c} = \frac{1}{\sqrt{1 - \frac{2Z}{W}}} f1(Z/b) \quad (\text{see Table C1})$$

$$Z = \text{Rad} + C$$

$\frac{Z}{b}$ , or $\frac{Z}{b}(b=w/2)$	f1	$\frac{Z}{b}$ , or $\frac{Z}{b}(b=w/2)$	f2	2Z/H	f3
0.00	1.00	0.00	1.00	1.00	0.00
.06	.98	.06	.98	1.0542	.1666
.12	1.	.13	.96	1.0666	.20
.19	1.06	.18	.955	1.075	.25
.34	1.24	.20	.95	1.0916	.333
.40	1.3	.26	.95	1.25	.50
.48	1.36	.32	.955	1.333	.5714
.54	1.38	.62	1.0	1.4166	.6315
.60	1.395	.70	1.01	1.525	.80
.72	1.395	.76	1.01	1.75	.8888
.80	1.38	.80	1.0	2.00	1.0909
.86	1.36	.86	.98	2.24	1.2632
.96	1.32	.90	.96	2.72	1.60
1.0	1.297	.94	.92	3.64	2.1819
		.97	.88	4.416	2.6666
		1.0	.826	8.00	4.8007

TABLE CI- Functions for Pin Loaded Lug

The stress intensity factor is composed of two basic parts, that due to the uniform stress ( $P/Wth$ ) and that due to the pin load  $P$ . The subscript  $\sigma$  in the equations, applies to the former and the subscript  $P$  refers to the latter.

The 1.05 factor on the pin load portion is there to account for the extra driving force due to the presence of Mode II stress intensity factors as well as Mode I.

The pin load and uniform stress portions of the expression are composed of factors accounting for the effect of the hole (subscripted by  $B$ ), the effect of the circular end (subscripted by  $C$ ) for the effect of the straight sides (subscripted by  $S$ ). The latter contains effects of the finite width (subscripted by  $w$ ), and height subscripted by  $H$ .

The expression for the effect of the hole has been described above.  $\phi_{\sigma,s}$  combines Feddersen's width effect and a tabular description of the effect of the height taken from the data of Fichter (Ref.C-4).  $\phi_{\sigma,c}$  is a tabular description of pg. 11.6 of (Ref. C-5).  $\phi_{p,c}$  is a tabular description of pg. 11.9 of Ref. (C-5).  $\phi_{p,H}$  is taken from Ref.(C-5) and  $\phi_{p,w}$  is the width effect presented by Tada (Ref. C-7). The effective half crack length used in Rad + C.

Pin loaded Lug - single through crack

$$K_c = \frac{P}{2th} \left[ \frac{1 + \frac{1}{9} \left( \frac{z+e}{z-e} \right) \sqrt{\frac{z-e}{z+e}}}{\sqrt{\pi z}} \phi_p + \frac{\sqrt{\pi C}}{W} \phi_\sigma \right]$$

$$\phi_\sigma = \frac{1}{2} (\phi_{\sigma,c} + \phi_{\sigma,s}) F_B$$

$$F_B = e^{(1.2133 - 2.225 S^2 + .6451 S^2)}$$

$$S = c / \text{Rad} + C$$

$$\phi_{\sigma,s} = \sqrt{\sec \frac{\pi z}{2B}} F_3 (Z/H)$$

$$b' = \frac{W}{2} - \frac{C}{2}$$

$$\phi_{\sigma,c} = \frac{1}{\sqrt{1 - \frac{z}{B}}} F_2 (Z/b')$$

$$\phi_p = \frac{1}{2} [\phi_{p,c} + \phi_{p,H} \phi_{p,w}]$$

$$\phi_{p,h} = 1 - .08\left(\frac{2Z}{H}\right) + 2.69\left(\frac{2Z}{H}\right)^2 - .99\left(\frac{2Z}{H}\right)^3$$

$$\phi_{p,h} = \frac{1}{1 - \frac{Z}{b'}} \left[ 1 - .5\left(\frac{Z}{b'}\right) + .957\left(\frac{Z}{b'}\right)^2 - .16\left(\frac{Z}{b'}\right)^3 \right]$$

$$\phi_{p,c} = \frac{1}{1 - \frac{Z}{b'}} F1(Z/B')$$

$$Z = \frac{C+2Rad}{2}$$

$$e = C/2$$

The above exceptions are generated in a similar manner to the double crack case except that:

- The single crack expression for the hole effect is used.
- The effective half crack length is  $(C+2Rad)/2$ .
- The effective half width is taken to be  $\frac{w}{2} - \frac{c}{2}$

#### Double crack at double notch

$$K_c = \phi_g \sqrt{\pi c} f_4 (S, \text{height}/b) F_w \quad (\text{See Table C-2})$$

$$S = c/b+c$$

$$F_w = \left[ \frac{1 + .122 \left( \cos \pi \left( \frac{b+c}{w} \right) \right)^4}{1.122} \right] \sqrt{\frac{w}{\pi(b+c)} \tan \frac{\pi(b+c)}{w}}$$

Where  $F_w$  is a modification of the double edge cracked tensile formula given by Tada (pg. 2.7) (Ref.C-5).

$f_4 (S, \text{height}/b)$

	S								
	.01	.05	.1	.2	.3	.4	.6	.8	1
0	11.22	5.02	3.55	2.51	2.05	1.77	1.45	1.25	1.122
.25	9.5	5.02	3.55	2.51	2.05	1.77	1.45	1.25	1.122
.333	8.4	5.02	3.55	2.51	2.05	1.77	1.45	1.25	1.122
.5	5.8	4.1	3.5	2.51	2.05	1.77	1.45	1.25	1.122
1	3.5	3	2.8	2.4	2.0	1.77	1.45	1.25	1.122
2	2.3	2.2	2.2	2	1.8	1.7	1.35	1.25	1.122
4	1.5	1.45	1.4	1.35	1.3	1.25	1.2	1.18	1.122
$\infty$	1.122	1.122	1.122	1.122	1.122	1.122	1.122	1.122	1.122

TABLE C-2

Function For Cracks at Notches

F4 (S, height/b) is a table constructed from the curves presented by Tada (pg. 19.13) for a crack emanating from an edge notch in a semi-infinite sheet.

Single crack at single edge notch.

$$K_c = \phi_g \sqrt{\pi C} f_4(S, \text{height}/b) F_w$$

$$F_w = \left[ \frac{.752 + 2.02 \left( \frac{b+c}{W} \right) + .37 \left( 1 - \sin \frac{\pi(b+c)}{2W} \right)}{1.122 \cos \frac{\pi(b+c)}{2W}} \right] \sqrt{\frac{2W}{\pi(b+c)} \tan \frac{\pi(b+c)}{2W}}$$

$$S = c/b+c$$

Where  $F_w$  is a modification of the single edge cracked tensile formula given by Tada (pg. 2.11, Ref. C-5).

Cracks coming out of shoulder

$$K_c = \phi_g \sqrt{\pi C} f_4(S, g) F_w \quad (\text{See Table C-2})$$

$$F_w = \frac{\left[ 1 + .122 \left( \cos \left( \frac{\pi(b'+c)}{W} \right) \right)^4 \right]}{1.122} \sqrt{\frac{W}{\pi(b'+c)} \tan \frac{\pi(b'+c)}{W}}$$

$$g = f_5\left(\frac{\text{rad}}{d}, w/d\right)$$

(See Table C-3)

$$b' = (w-d)/z$$

$$S = c/c+b'$$

The above solution for the stress intensity factor is based on using the solution for the case of cracks coming out of a doubly



$$f_5 \left( \frac{\text{Rad}}{d} w/d \right)$$

<u>w/d</u>												
	1.01	1.02	1.05	1.07	1.1	1.15	1.2	1.3	1.5	2	3	
<u>rad/d</u>	.02	1.75	1.2	.95	.87	.82	.75	.55	.44	3.6	2.6	.18
	.04	3	1.75	1.38	1.25	1.12	1.15	1.15	1.1	1.35	1.7	3
	.06	4	2.8	1.85	1.63	1.5	1.5	1.45	1.42	2	5	5
	.08	4.5	3.5	2	2	1.87	2	1.85	1.84	3.5	5	7
	.1	5	4	3	2.7	2.3	2.6	2.25	3.3	4.4	6	8
	.12	6	4.3	3.3	3.1	3	4.4	5	5	5	6.5	9
	.14	7	4.7	3.6	3.5	3.5	5	6.3	6	6	7	10
	.18	8	5	4	4	4	6.5	7.5	7.5	8	9	11
	.22	8.5	6	4.5	4.4	4.5	7.5	8.5	8.5	9	10	12
	.26	9	6.5	4.75	4.7	4.75	8.5	8.5	9.5	10	11	12
.3	9	7	5	5	5	9.5	9.5	10	11	12	12	

TABLE C-3

notched plate, whose notch dimensions are chosen such that the notch depth is equal to  $(W-d)/2$  and the notch height is such that the stress concentration factor in the shoulder is the same as that at the notch. The table used to generate "g" is developed using the stress concentrations for a shoulder fillet (Ref. (C-6) and the stress concentration factor for a notch in a finite width plate.

#### Part Through Cracks

Basic Part through crack solution.

$$B = \text{minimum } (a, c)$$

$$K_c = \sigma_g \sqrt{\pi B} F(a/c, 2)$$

(See Table C-4)

$$K_a = \sigma_g \sqrt{\pi B} F(a/c, 1)$$

Where the function  $F$  is given in Table C-4 and accounts for the effect of crack shape.

The stress intensity equations for part through cracks in varying geometries were constructed using the above relations, the through crack equations for each geometry and the following rules.

- 1) The effect of the back surface on the stress intensity factor at the crack depth is considered for the center part through crack. This factor is

TABLE C-4

## Part Through Crack Shape Factors

<u>a/c</u>	<u>F(a/c,1)</u>	<u>F(a/c,2)</u>
0	1.122	0
.04	1.11	0.17
.07	1.10	0.27
.12	1.08	0.37
.15	1.07	0.42
.21	1.04	0.5
.34	0.97	0.6
.58	0.84	0.71
.72	0.77	0.74
.775	0.75	0.75
.86	0.75	0.76
1.0	0.655	0.775
1.25	0.65	0.82
1.49	.63	0.86
1.785	0.61	0.9
2.325	0.57	0.96
3.45	0.5	0.975
5.0	0.43	0.99
6.66	0.38	0.998
10.0	0.31	1.0
25.0	0.17	1.0
50.0	0.1	1.0
100.0	0.15	1.0
10000.	0	1.0

$$\begin{aligned}
M_{\text{back}} = 1 + \frac{1}{0.502} & \left[ 0.089 \left( \frac{a}{t} \right) - 0.2315 \left( \frac{a}{t} \right)^2 \right. \\
& - 0.3873 \left( \frac{a}{t} \right)^3 + 5.28 \left( \frac{a}{t} \right)^4 - 9.11 \left( \frac{a}{t} \right)^5 + 5.233 \left( \frac{a}{t} \right)^6 \Big] \\
& \times \left[ 1.109 - 9.142 \left( \frac{a}{2c} \right) + 41.56 \left( \frac{a}{2c} \right)^2 - 86.55 \left( \frac{a}{2c} \right)^3 \right. \\
& \left. \left. + 65.5 \left( \frac{a}{2c} \right)^4 \right] \quad (\text{Ref. C-7})
\end{aligned}$$

For cracks coming out of holes, notches and radii, there is strong evidence (Ref.C-8) that the effect of the back surface effect is minimal and therefore it has not been included.

- 2) In using those parts of the through crack equation that deal with the effect of a local stress concentration (such as the Bowie correction factor  $F_B$ ) the effect of the stress concentration at both the surface and depth of the crack is evaluated by using the leading crack position. The use of other positions (and therefore higher factors) has been shown to be an over estimate of the effect.
- 3) In accounting for the affects of finite widths, the actual position of the portion of the crack front for which the stress intensity is being evaluated is used in calculating the effect of the finite width.
- 4) For an embedded flow, care is taken that the free edge of the notch or hole is not accounted for twice (i.e., through the basic ptc equation and through the through crack equations)

thus, it is necessary to factor out 1.122 from the combination of ptc and through crack equations.

- 5) For the embedded flaws, the roles of  $F(a/c,2)$  and  $F(a/c,1)$  with respect to the stress intensity at the depth and surface are switched.
- 6) "a" is always taken to be in the thickness direction. "c" is always perpendicular to the thickness directions and identical to the through crack definition of "c".

### Transition Crack

$$K_c = K_c \left( \frac{C+C_b}{2} \right)$$

where

$K_c \left( \frac{C+C_b}{2} \right)$  is the appropriate through crack equation with "c" replaced by  $\left( \frac{C+C_b}{2} \right)$

$$K_a = \sqrt{\left[ (CB/C) / \left( 1 - \left( 1 - \left( \frac{CB}{C} \right)^2 \right)^{1/2} \right) \right]}$$

$K_c$  is the stress intensity for the leading portion of the crack front and  $K_a$  is the stress intensity for the trailing portion.

The above equation is an approximate expression developed by R.M. Ehret (Ref.C-9) which predicts observed crack growth behavior.

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COMMON X(12,25),Y(12,25),TABLE(12,25,25),FIXED,KCPRF,KAPPF, 00000010
1 PROGF,X,NKTMX,NPX(12),NPY(12),NTAB(10),IPLOT,IFAIL,CUMSUM,PCYC(2) 00000020
COMMON A,AP(2),ALIM,AOL(2),C,CB,CLIM,CR(2,10,10),CO,CUME, 00000030
1 CUMELM,CIBI,D(2,10,10),DK,DKE,DXDX,FA,FC,H,INC,KCL,KC1,KOL, 00000040
2 KOA,KOC,KCRA,KCRC,KMAX,CA,OC,PI,R,RAD,RE,RVOL(2),ROL(2), 00000050
3 SIG,SIGLM,SIGY,SIGYS(10),SMIN(422),SMAX(422),TH, 00000060
4 UNIT(422),W,DCTMP,DFTMP,DXTMP, 00000070
5 ALOWN,BLOCK,FLAG1,I,ICD(2),ICK(2),ICR(2),IBLOCK,IFIRST,IPRN(4), 00000080
6 ISTEP,TTRANS,J,KTYPE(2),NC,NEQ(10),NR,NRET(10),TYPE,TITL 00000090
DIMENSION THICK(10),PCTLF(10),A1(10),CI(10) 00000100
DIMENSION FL(4,3),KTYPO(2),KTN(3,2) 00000110
DIMENSION HMIN(422),HMAX(422) 00000111
INTEGER ALOWN,BLOCK,FLAG1,TYPE(422),CNSTEP,TITL(20) 00000120
INTEGER HNSTEP 00000121
INTEGER PD1(2),PD2(4),PD3(4) 00000130
REAL KCL,KC1,KOL,KOA(10),KOC(10),KCRA(10),KCRC(10),KMAX,INC 00000140
REAL LIFE(10),KCPRF,KAPRF 00000150
DATA PD1 /4HR A ,4HR C / 00000160
DATA PD2 /4HA/C ,4HFIXF,4HC ,4HA / 00000170
DATA PD3 /4H ,4HD ,4H ,4H / 00000180
DATA FL /4H DEP,4HSURE,4HBREA,4H TRA,4HTH ,4HACE ,4HKTMR,4HNSIT, 00000190
1 4H ,4H ,4HOUCH,4HION / 00000200
DATA KTN /4H PT,4HTRAN,4H T,4HC - ,4HS - ,4HC - / 00000210
DATA KEND /4H END/ 00000220
C 00000230
C 00000240
C 00000250
DO 10 I=1,2 00000260
DO 10 J=1,10 00000270
NTAB(J)=0 00000280
DO 10 K=1,10 00000290
D(I,J,K)=0 00000300
10 CR(I,J,K)=0 00000310
PI=3.1415927 00000320
DCTMP=0. 00000330
DFTMP=0. 00000340
DXTMP=0. 00000350
CNSTEP=-1 00000360
NR=0 00000370
C 00000380
C 00000390
C 00000400
C 00000410
C 00000420
C 00000430
C 00000440
C 00000450
C 00000460
C 00000470
C 00000480
C 00000490
C 00000500
C 00000510
C 00000520
C 00000530
C 00000540
C 00000550
C 00000560
C 00000570
C 00000580

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I2=I1-I+1	00000590
DO 36 L1=I2,I1	00000600
L=I1+I2-L1	00000610
J=L-K	00000620
TITL(L)=TITL(J)	00000630
TITL(J)=PD3(1)	00000640
36 CONTINUE	00000650
C	00000660
C READ CONTROL INFO FOR INDIVIDUAL RUN	00000670
C	00000680
C CSTRS = STRESS MULTIPLIER NSUP = 0 TO SUPPRESS RETARDATION	00000690
C NLOAD = 1 FOR LOAD INPUT NGEOM = 1 FOR GEOMETRY INPUT	00000700
C NMAT = 1 FOR MATERIAL INPUT NPROOF= 1 FOR PROOF INPUT	00000710
C ITERTP= ITERATION TYPE (OPT) ITER = # OF ITERATIONS	00000720
C PIT = CONVERGENCE PARAM BLIFE = DESIRED LIFE IN BLOCKS	00000730
C PLOT > 0 TO GENERATE PLOT PCYCLES(1)=PLOT FREQ (CYCLES) (OPT)	00000740
C	00000750
100 READ (5,5003) CSTRS,NSUP,NLOAD,NGEOM,NMAT,ITERTP,ITER,PIT,BLIFE,	00000760
1 NPROOF,IPLLOT,PCYC(1)	00000770
IF (ITER.LT.1) GO TO 110	00000780
IF (ITERTP.EQ.0) GO TO 4020	00000790
IF (ITERTP.GT.4) GO TO 4020	00000800
110 DO 120 K=1,10	00000810
120 NRET(K)=NSUP*NRET(K)	00000820
ITCNT=0	00000830
IF (IPLLOT.EQ.0) GO TO 130	00000840
IPLLOT=1	00000850
IF (PCYC(1).EQ.0) GO TO 130	00000860
IPLLOT=2	00000870
130 IF (ITER-10) 800,800,140	00000880
140 ITER=10	00000890
C	00000900
C READ LOAD INPUT	00000910
C	00000920
800 IF (NLOAD-1) 910,810,910	00000930
810 READ (5,5004) NSTEP,IR,SIGLM	00000940
IF (MSTEP-(ONSTEP+1)) 820,830,820	00000950
820 IF (MSTEP) 840,830,840	00000960
830 MSTEP=NSTEP+1	00000970
840 DO 850 I=1,NSTEP	00000980
850 READ (5,5005) SMAX(I),SMIN(I),UNIT(I),TYPE(I)	00000990
IF (IR-1) 880,860,880	00001000
860 DO 870 I=1,NSTEP	00001010
870 SMIN(I)=SMIN(I)*SMAX(I)	00001020
880 IF (CSTRS) 890,910,890	00001030
890 SIGLM = CSTRS*SIGLM	00001040
DO 900 I=1,NSTEP	00001050
SMIN(I)=CSTRS*SMIN(I)	00001060
900 SMAX(I)=CSTRS*SMAX(I)	00001070
C	00001080
C READ GEOMETRY INPUT	00001090
C	00001100
910 IF (NGEOM-1) 1100,920,1100	00001110
920 READ (5,5004) KTYPO	00001120
READ (5,5006) W,TH,CO,AO,H,RAD	00001130
OTH=TH	00001140
DAO=AO	00001141
DCO=CO	00001142
IF (KTYPO(1).LT.1) GO TO 4030	00001150
IF (KTYPO(1).GT.3) GO TO 4030	00001160



IF (KTYP0(2).LT.1) GO TO 4060	00001170
IF (KTYP0(2).GT.17) GO TO 4060	00001180
IF (KTYP0(2).EQ.7) GO TO 940	00001190
IF (KTYP0(2).EQ.16) GO TO 930	00001200
IF (KTYP0(2).EQ.17) GO TO 930	00001210
GO TO 1100	00001220
930 C1B1 = FUNT5(RAD/H,W/H)	00001230
GO TO 1100	00001240
C	00001250
C READ X,Y, TABLE ARRAYS(1-6) FOR INTERPOLATION	00001260
C	00001270
C NKTMX = ONE HALF # ARRAY ELEMENTS	00001280
C	00001290
940 READ(5,5002) NKTMX	00001300
IF (NKTMX.LT.1) GO TO 980	00001310
IF (NKTMX.LT.4) GO TO 990	00001320
980 WRITE(6,6024) NKTMX	00001330
STOP	00001340
990 NTABLE=6	00001350
N1=1	00001360
N2=2*NKTMX	00001370
DO 1090 NT=N1,N2	00001380
IF (AO.NE.0.) GO TO 1000	00001390
I=MOD(NT,2)	00001400
IF (I.NE.0) GO TO 1000	00001410
X(NT,1)=0.	00001420
Y(NT,1)=0.	00001430
NOX(NT)=1	00001440
NOY(NT)=1	00001450
TABLE(NT,1,1) = 0.	00001460
GO TO 1090	00001470
1000 READ(5,5009) X(NT,1),LEND	00001480
I=1	00001490
IF (LEND.EQ.KEND) GO TO 1030	00001500
DO 1020 I=2,25	00001510
READ(5,5009) X(NT,I),LEND	00001520
IF (X(NT,I).LE.X(NT,I-1)) GO TO 4000	00001530
1020 IF (LEND.EQ.KEND) GO TO 1030	00001540
GO TO 4010	00001550
1030 NOX(NT)=I	00001560
IF (AO.NE.0.) GO TO 1040	00001570
Y(NT,1)=0.	00001580
Y(NT,2)=1.	00001585
I=2	00001590
GO TO 1070	00001600
1040 READ(5,5009) Y(NT,1),LEND	00001610
I=1	00001620
IF (LEND.EQ.KEND) GO TO 1070	00001630
DO 1060 I=2,25	00001640
READ(5,5009) Y(NT,I),LEND	00001650
IF (Y(NT,I).LE.Y(NT,I-1)) GO TO 4000	00001660
1060 IF (LEND.EQ.KEND) GO TO 1070	00001670
GO TO 4010	00001680
1070 NOY(NT)=I	00001690
I1=NOX(NT)	00001700
I2=NOY(NT)	00001710
DO 1080 I=1,I1	00001720
READ(5,5008) (TABLE(NT,I,I3), I3=1,I2)	00001730
IF (AO.NE.0.) GO TO 1080	00001731
TABLE(NT,I,2) = TABLE(NT,I,1)	00001732

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1080	CONTINUE	00001733
1090	CONTINUE	00001740
C		00001750
C	READ MATERIAL INPUT	00001760
C		00001770
1100	IF (NMAT-1) 1490,1110,1490	00001780
1110	READ (5,5002) NJ	00001790
	NTABLE=6	00001800
C		00001810
	DO 1450 J=1,NJ	00001820
C		00001830
	NTAB(J)=0	00001840
	READ (5,5007) SIGYS(J),NEQ(J),NPET(J),NDUP,	00001850
1	KCRC(J),KOC(J),KCRA(J),KOA(J)	00001860
	NRET(J)=NSUP*NRET(J)	00001870
	IF (NEQ(J).NE.4) GO TO 1240	00001880
C		00001890
C	READ X,Y, TABLE ARRAYS(7-12) FOR NEQ(J)=4 & JK4	00001900
C		00001910
	NTABLE=NTABLE+1	00001920
	IF (NTABLE.GT.12) GO TO 1340	00001930
	NTAB(J)=NTABLE	00001940
	IF (J.GT.3) GO TO 1240	00001950
	N1=NTAB(J)	00001960
	N2=N1+1	00001970
	DO 1230 NT=N1,N2	00001980
	IF (NDUP.EQ.1) GO TO 1140	00001990
	I=MOD(NT,2)	00002000
	IF (I.NE.0) GO TO 1140	00002010
	I=NT-1	00002020
	NOX(NT)=NOX(I)	00002030
	NOY(NT)=NOY(I)	00002040
	I1=NOX(I)	00002050
	I2=NOY(I)	00002060
	DO 1120 I3=1,I2	00002070
1120	Y(NT,I3)=Y(I,I3)	00002080
	DO 1130 I3=1,I1	00002090
	X(NT,I3)=X(I,I3)	00002100
	DO 1130 I4=1,I2	00002110
1130	TABLE(NT,I3,I4)=TABLE(I,I3,I4)	00002120
	GO TO 1230	00002130
C		00002140
C	READ X ARRAY	00002150
C		00002160
1140	READ(5,5009) X(NT,1),LEND	00002170
	I=1	00002180
	IF (LEND.EQ.KEND) GO TO 1170	00002190
	DO 1160 I=2,25	00002200
	READ(5,5009) X(NT,I),LEND	00002210
	IF (X(NT,I).LE.X(NT,I-1)) GO TO 4000	00002220
1160	IF (LEND.EQ.KEND) GO TO 1170	00002230
	GO TO 4010	00002240
1170	NOX(NT)=I	00002250
C		00002260
C	READ Y ARRAY	00002270
C		00002280
	READ(5,5009) Y(NT,1),LEND	00002290
	I=1	00002300
	IF (LEND.EQ.KEND) GO TO 1200	00002310
	DO 1190 I=2,25	00002320



READ(5,5009) Y(NT,I),LEND	00002330
IF (Y(NT,I).LE.Y(NT,I-1)) GO TO 4000	00002340
1190 IF (LEND.EQ.KEND) GO TO 1200	00002350
GO TO 4010	00002360
1200 NCY(NT)=I	00002370
I1=NCX(NT)	00002380
I2=NOY(NT)	00002390
DO 1210 I=1,I1	00002400
1210 READ(5,5008) (TABLE(NT,I,I3), I3=1,I2)	00002410
I3=NCY(NT)	00002420
I2=I3+1	00002430
NOY(NT)=I2	00002440
Y(NT,I2)=1.	00002450
DO 1220 I=1,I1	00002460
1220 TABLE(NT,I,I2)=TABLE(NT,I,I3)	00002470
1230 CONTINUE	00002480
NTABLE=NTABLE+1	00002490
GO TO 1340	00002500
C	00002510
C READ D ARRAY FOR NFG(J) NOT = 4	00002520
C	00002530
1240 DO 1250 I=1,10	00002540
D(1,I,J)=0	00002550
1250 D(2,I,J)=0	00002560
DO 1260 I=1,10	00002570
READ (5,5009) D(1,I,J),LEND	00002580
1260 IF (LEND.EQ.KEND) GO TO 1270	00002590
GO TO 4070	00002600
1270 IF (NDUP-1) 1280,1300,1280	00002610
1280 DO 1290 I=1,10	00002620
1290 D(2,I,J)=D(1,I,J)	00002630
GO TO 1340	00002640
1300 DO 1310 I=1,10	00002650
READ (5,5009) D(2,I,J),LEND	00002660
1310 IF (LEND.EQ.KEND) GO TO 1340	00002670
GO TO 4070	00002680
1340 IF (NRET(J)) 1350,1450,1350	00002690
1350 DO 1360 I=1,10	00002700
CR(1,I,J)=0	00002710
1360 CR(2,I,J)=0	00002720
DO 1370 I=1,10	00002730
READ (5,5009) CR(1,I,J),LEND	00002740
1370 IF (LEND.EQ.KEND) GO TO 1380	00002750
GO TO 4070	00002760
1380 IF (NDUP-1) 1390,1410,1390	00002770
1390 DO 1400 I=1,10	00002780
1400 CR(2,I,J)=CR(1,I,J)	00002790
GO TO 1450	00002800
1410 DO 1420 I=1,10	00002810
READ (5,5009) CR(2,I,J),LEND	00002820
1420 IF (LEND.EQ.KEND) GO TO 1450	00002830
GO TO 4070	00002840
1450 CONTINUE	00002850
C	00002860
C READ PROOF INPUT DATA	00002870
C	00002880
1490 IF (NPROOF.EQ.0) GO TO 1500	00002890
READ(5,5010) FIXED,KCPRE,KAPRE,XLOW,XUP,PROCFX,IFND	00002900
C	00002910
C INCREMENT RUN # & VERIFY COMPLETE INPUT	00002920

C		00002930
1500	NR=NR+1	00002940
	IF (NR-1) 1510,1510,1530	00002950
1510	I=NLOAD+NLOAD+NMA1	00002960
	IF (I-3) 4050,1520,4050	00002970
1520	OCSTRS=CSTRS	00002980
	ONSTEP=NSTEP	00002990
	GO TO 1620	00003000
1530	IF (NLOAD-1) 1540,1520,1540	00003010
1540	IF (OCSTRS-CSTRS) 1550,1620,1550	00003020
1550	IF (OCSTRS) 1580,1560,1580	00003030
1560	DO 1570 I=1,ONSTEP	00003040
	S MIN(I)=S MIN(I)*CSTRS	00003050
1570	S MAX(I)=S MAX(I)*CSTRS	00003060
	S IGLM = CSTRS*S IGLM	00003070
	OCSTRS=CSTRS	00003080
	GO TO 1620	00003090
1580	DO 1590 I=1,ONSTEP	00003100
	S MIN(I)=S MIN(I)/OCSTRS	00003110
1590	S MAX(I)=S MAX(I)/OCSTRS	00003120
	S IGLM = S IGLM/OCSTRS	00003130
	OCSTRS=CSTRS	00003140
	IF (CSTRS) 1600,1620,1600	00003150
1600	DO 1610 I=1,ONSTEP	00003160
	S MIN(I)=S MIN(I)*CSTRS	00003170
1610	S MAX(I)=S MAX(I)*CSTRS	00003180
	S IGLM = CSTRS*S IGLM	00003190
1620	HNSTEP=NSTEP	00003191
	HSIGLM=S IGLM	00003192
	HCSTRS=CSTRS	00003193
	DO 1622 I=1,HNSTEP	00003194
	H MIN(I)=S MIN(I)	00003195
1622	H MAX(I)=S MAX(I)	00003196
1625	IF (IPLOT.NE.1) GO TO 1630	00003200
	K=NBLOCK/MBLOCK	00003210
	IF (K.EQ.0) GO TO 4040	00003220
	K=NSTEP/MSTEP	00003230
	IF (K.EQ.0) GO TO 4040	00003240
C		00003250
C	DISPLAY ALL INPUT FOR EACH ITERATION OF EACH RUN	00003260
C		00003270
1630	WRITE(6,8002) NR,NRUNS,TITL	00003280
C		00003290
C	DISPLAY LOAD INPUT	00003300
C		00003310
	WRITE(6,8003) CSTRS,S IGLM	00003320
	BCYCLE=0.	00003330
	DO 1640 J1=1,NSTEP	00003340
	BCYCLE = BCYCLE + UNIT(J1)	00003350
1640	WRITE(6,8004) J1,S MAX(J1),S MIN(J1),UNIT(J1),TYPE(J1)	00003360
C		00003370
C	DISPLAY GEOMETRY INPUT	00003380
C		00003390
	WRITE(6,8005) KTN(KTYP0(1),1),KTN(KTYP0(1),2),KTYP0(2),W,H,RAD,TH	00003400
	IF (KTYP0(1)-3) 1660,1650,1660	00003410
1650	WRITE(6,8007) C0	00003420
	GO TO 1665	00003430
1660	WRITE(6,8006) A0	00003440
	WRITE(6,8007) C0	00003450
1665	IF (KTYP0(2).NE.7) GO TO 1750	00003460



N1=2*NKTMX	00003470
DO 1740 NT=1,N1	00003480
I1=MOD(NT,2)	00003490
IF (I1.EQ.0) GO TO 1670	00003500
WRITE(6,8014) NT	00003510
GO TO 1680	00003520
1670 WRITE(6,8017) NT	00003530
1680 CONTINUE	00003540
I2=NDY(NT)	00003550
I1=NDX(NT)	00003560
J1=1	00003570
J2=8	00003580
1690 IF (J2-I2) 1710,1710,1700	00003590
1700 J2=I2	00003600
1710 WRITE(6,8015) (Y(NT,I3), I3=J1,J2)	00003610
DO 1720 I=1,I1	00003620
1720 WRITE(6,8016) X(NT,I),(TABLE(NT,I,I3), I3=J1,J2)	00003630
IF (I2-J2) 1730,1740,1730	00003640
1730 J1=J1+8	00003650
J2=J2+8	00003660
GO TO 1690	00003670
1740 CONTINUE	00003680
C	00003690
C DISPLAY MATERIAL INPUT	00003700
C	00003710
1750 WRITE(6,8008)	00003720
DO 1760 J1=1,NJ	00003730
WRITE(6,8009) J1,SIGYS(J1),NEQ(J1),NRET(J1),KCRC(J1),KOC(J1),	00003740
1 KCRA(J1),KCA(J1)	00003750
1760 CONTINUE	00003760
C	00003770
C DISPLAY D & CR ARRAYS IF ANY	00003780
C	00003790
K=0	00003800
DO 1840 J1=1,NJ	00003810
IF (NEQ(J1).NE.4) GO TO 1770	00003820
IF (J1.GT.3) GO TO 1770	00003830
GO TO 1840	00003840
1770 IF (K.GT.0) GO TO 1780	00003850
K=K+1	00003860
WRITE(6,8010)	00003870
1780 DO 1830 J2=1,10	00003880
IF (D(1,J2,J1)) 1820,1790,1820	00003890
1790 IF (D(2,J2,J1)) 1820,1800,1820	00003900
1800 IF (CR(1,J2,J1)) 1820,1810,1820	00003910
1810 IF (CR(2,J2,J1)) 1820,1830,1820	00003920
1820 WRITE(6,8011) J2,J1,D(1,J2,J1),D(2,J2,J1),	00003930
1 CR(1,J2,J1),CR(2,J2,J1)	00003940
1830 CONTINUE	00003950
1840 CONTINUE	00003960
C	00003970
C DISPLAY TABLES 7-12 IF ANY	00003980
C	00003990
DO 1910 J=1,NJ	00004000
IF (NEQ(J).NE.4) GO TO 1910	00004010
IF (J.GT.3) GO TO 1910	00004020
N1=NTAB(J)	00004030
N2=N1+1	00004040
DO 1900 NT=N1,N2	00004050
WRITE(6,8019) J,NT	00004060

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I2=NOY(NT)	00004070
I1=NOX(NT)	00004080
J1=1	00004090
J2=8	00004100
1850 IF (J2-I2) 1870,1870,1860	00004110
1860 J2=I2	00004120
1870 WRITE(6,8020) (Y(NT,I3), I3=J1,J2)	00004130
DO 1880 I=1,I1	00004140
1880 WRITE(6,8021) X(NT,I),(TABLE(NT,I,I3), I3=J1,J2)	00004150
IF (I2-J2) 1890,1900,1890	00004160
1890 J1=J1+8	00004170
J2=J2+8	00004180
GO TO 1850	00004190
1900 CONTINUE	00004200
1910 CONTINUE	00004210
C	00004220
C DISPLAY PROOF INPUT IF ANY	00004230
C	00004240
IF (NPROOF) 1940,1940,1920	00004250
1920 N1=NPROOF+1	00004260
N1=MOD(N1,2) + 1	00004270
IF (IEND.GT.0) GO TO 1930	00004280
IEND=100	00004290
1930 WRITE(6,8018) NPROOF,PD1(N1),XLOW,PROOFX,PD1(N1),XUP,KCPRF,	00004300
1 PD2(NPROOF),PD3(NPROOF),FIXED,KAPRF,IEND	00004310
1940 IF (ITER) 1960,1960,1950	00004320
1950 K=ITCNT+1	00004330
WRITE(6,8012) BLIFE,PIT,K,ITERTP	00004340
1960 CONTINUE	00004350
C	00004360
C INITIALIZATION FOR EACH RUN	00004370
C	00004380
ICK(1)=0	00004390
ICK(2)=20	00004400
ICD(1)=0	00004410
ICD(2)=20	00004420
ICR(1)=0	00004430
ICR(2)=20	00004440
INC=.01	00004450
ING=0	00004460
BLOCK=1	00004470
I=1	00004480
ITRANS=0	00004490
IPRN(1)=-1	00004500
IPRN(2)=-1	00004510
IPRN(3)=-1	00004520
IPRN(4)=2*NSTEP	00004530
FLAG1=0	00004540
CUME=0	00004550
KTYPE(1)=KTYPO(1)	00004560
KTYPE(2)=KTYPO(2)	00004570
PCYC(2)=PCYC(1)	00004580
IFAIL=0	00004590
CUMSUM=0.	00004600
IF (NPROOF) 1980,1980,1970	00004610
1970 CALL PROOF(AO,CO,XLOW,XUP,IEND,NPROOF)	00004620
1980 CONTINUE	00004630
C=CO	00004640
A=AO	00004650
OA=A	00004660



C	DC=C	00004670
C	AP(1)=C0	00004680
C	AP(2)=A0	00004690
C	RYOL(1)=0	00004700
C	ALOWN=0	00004710
C	RYOL(2)=0	00004720
C	KOL=0	00004730
C	KCL=0	00004740
C	KC1=0	00004750
C	WRITE TITLE, #CYCLES/BLOCK, & FIRST DATA POINT IF PLOT WANTED	00004760
C	IF (IPLOT.EQ.0) GO TO 2000	00004770
C	WRITE(7,7010) (TITL(I1), I1=1,15),BCYCLE	00004780
C	WRITE(7,7000) A,C,CUMSUM	00004790
C	BEGINNING OF EACH STEP, EACH BLOCK	00004800
C	2000 IF (MOD(BLOCK,MBLOCK)) 2050,2010,2050	00004810
C	2010 IF (MOD(I,MSTEP)) 2050,2020,2050	00004820
C	2020 DO 2040 K=1,3	00004830
C	IF (IPRN(K)-IPRN(4)) 2040,2030,2040	00004840
C	2030 IPRN(K)=IPRN(K)-2	00004850
C	2040 CONTINUE	00004860
C	2050 IF (ITRANS-1) 2070,2060,2070	00004870
C	2060 CALL TRANS	00004880
C	GO TO 2100	00004890
C	2070 KT=KTYPE(1)	00004900
C	GO TO (2090,2060,2080), KT	00004910
C	2080 CALL TCGROW	00004920
C	GO TO 2100	00004930
C	2090 CALL PTCGRW	00004940
C	HAS THE RUN ENDED?	00004950
C	2100 MORE=0	00004960
C	IF (ICR(1)+1) 2310,2310,2200	00004970
C	2200 CUME = 0	00004980
C	I=I+1	00004990
C	IS THIS THE LAST STEP OF THIS BLOCK?	00005000
C	IF (I-NSTEP) 2000,2000,2210	00005010
C	2210 BLOCK=BLOCK+1	00005020
C	IF (KTYPE(1).GT.1) GO TO 2230	00005030
C	IF (A-DA)2300,2230,2300	00005040
C	2230 IF (C-DC) 2300,2240,2300	00005050
C	2240 IF (DELTMP-1.E-8) 2250,2300,2300	00005060
C	2250 IF (DXTMP-1.E-8) 2260,2300,2300	00005070
C	2260 IF (ITRANS-1) 2270,2280,2270	00005080
C	2270 IF (KTYPE(1).GT.1) GO TO 2290	00005090
C	2280 IF (DCTMP-1.E-8) 2290,2300,2300	00005100
C	2290 WRITE(6,6020)	00005110
C	ING=1	00005120
C	GO TO 2310	00005130
C	2300 CA=A	00005140
C	DC=C	00005150
C	I=1	00005160
C	IS THIS THE LAST BLOCK OF THIS RUN?	00005170
C		00005180
C		00005190
C		00005200
C		00005210
C		00005220
C		00005230
C		00005240
C		00005250
C		00005260

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C		00005270
	IF (BLOCK-NBLOCK) 2000,2000,2310	00005280
C		00005290
C	ARE THERE ITERATIONS?	00005300
C		00005310
	2310 IF (ITER) 3000,3000,2320	00005320
C		00005330
C	ITERATION CALCULATIONS	00005340
C		00005350
	2320 ITCNT=ITCNT+1	00005360
	THICK(ITCNT)=TH	00005370
	AI(ITCNT)=AO	00005380
	CI(ITCNT)=CO	00005390
	LIFE(ITCNT)=FLOAT(BLOCK-1)+FLOAT(I)/FLOAT(NSTEP)	00005400
	LIFE(ITCNT)=LIFE(ITCNT)-((UNIT(I)-CUME)/UNIT(I))/FLOAT(NSTEP)	00005410
	PCTLF(ITCNT)=LIFE(ITCNT)*100./BLIFE	00005420
	IF (LIFE(ITCNT).EQ.C.) GO TO 2435	00005430
	DIF=PCTLF(ITCNT)/100.	00005440
	IF (DIF-.99) 2340,2340,2330	00005450
	2330 IF (DIF-1.05) 2440,2340,2340	00005460
	2340 IF (ITCNT-ITER) 2350,2440,2440	00005470
	2350 MORE=1	00005480
	IF (ITERTP.GT.1) GO TO 2400	00005490
	DIF=(BLIFE/LIFE(ITCNT))*((1./PIT)	00005500
	TH=TH*DIF	00005510
	IF(CSTRS) 2380,2360,2380	00005520
	2360 CSTRS=1./DIF	00005530
	DO 2370 K=1,ONSTEP	00005540
	S MIN(K)=S MIN(K)*CSTRS	00005550
	2370 S MAX(K)=S MAX(K)*CSTRS	00005560
	S IGLM=S IGLM*CSTRS	00005570
	OCSTRS=CSTRS	00005580
	GO TO 3000	00005590
	2380 CSTRS=CSTRS/DIF	00005600
	DO 2390 K=1,ONSTEP	00005610
	S MIN(K)=S MIN(K)/OCSTRS*CSTRS	00005620
	2390 S MAX(K)=S MAX(K)/OCSTRS*CSTRS	00005630
	S IGLM=S IGLM/OCSTRS*CSTRS	00005640
	OCSTRS=CSTRS	00005650
	GO TO 3000	00005660
	2400 DIF=(LIFE(ITCNT)/BLIFE)*((2./PIT-2.))	00005670
	GO TO (2350,2410,2420,2430), ITERTP	00005680
	2410 CO=CO*DIF	00005690
	GO TO 3000	00005700
	2420 AO=AO*DIF	00005710
	GO TO 3000	00005720
	2430 ADOVC0=AO/CO	00005730
	CO=CO*DIF	00005740
	AO=ADOVC0*CO	00005750
	GO TO 3000	00005760
	2435 WRITE(6,6160)	00005770
	MORE=0	00005780
	2440 WRITE(6,6021)	00005790
	DO 2450 K=1,ITCNT	00005800
	2450 WRITE(6,6022) THICK(K),AI(K),CI(K),LIFE(K),PCTLF(K)	00005810
	CSTRS=HCSTRS	00005811
	NSTEP=HNSTEP	00005812
	S IGLM=HSIGLM	00005813
	DO 2455 I=1,NSTEP	00005814
	S MIN(I)=HMIN(I)	00005815



2455	SMAX(I)=HMAX(I)	00005816
	TH=OTH	00005820
	CO=OCO	00005821
	AO=OAO	00005822
	IF (ING-1) 3000,2460,3000	00005830
2460	WRITE(6,8013)	00005840
C		00005850
C	WRITE FINAL DATA FOR PLOT IF ANY	00005860
C		00005870
3000	IF (IPL0T.EQ.0) GO TO 3040	00005880
	WRITE(7,7000) A,C,CUMSUM	00005890
	WRITE(7,7020)	00005900
	IF (IFAIL.GT.2) GO TO 3015	00005910
	IF (IFAIL.GT.0) GO TO 3010	00005920
	WRITE(7,7030)	00005930
	GO TO 3020	00005940
3010	WRITE(7,7040) FL(IFAIL,1),FL(IFAIL,2),BLOCK,I,CUMF,CUMSUM	00005950
	GO TO 3020	00005960
3015	WRITE(7,7070) (FL(IFAIL,11), 11=1,3),BLOCK,I,CUMF,CUMSUM	00005970
3020	IF (ITER.EQ.0) GO TO 3030	00005980
	WRITE(7,7050) THICK(ITER),AL(ITER),CI(ITER)	00005990
	GO TO 3040	00006000
3030	WRITE(7,7060)	00006010
C		00006020
C	IS THIS THE LAST RUN?	00006030
C		00006040
3040	IF (MORE.EQ.1) GO TO 1625	00006050
	IF (NR-NRUNS) 3050,3990,3990	00006060
3050	IF (ICR(1)+1) 3060,100,3060	00006070
3060	IF (FLAG1) 100,100,3070	00006080
3070	WRITE(6,6019) IBLOCK,ISTEP,CUMELM	00006090
	GO TO 100	00006100
3990	STOP	00006110
4000	WRITE(6,6100)	00006120
	STOP	00006130
4010	WRITE(6,6110)	00006140
	STOP	00006150
4020	WRITE(6,6120) ITERTP	00006160
	STOP	00006170
4030	WRITE(6,6130) KTYPE(1)	00006180
	STOP	00006190
4040	WRITE(6,6150)	00006200
	STOP	00006210
4050	WRITE(6,6001)	00006220
	STOP	00006230
4060	WRITE(6,6130) KTYPE(2)	00006240
	STOP	00006250
4070	WRITE (6,6140)	00006260
	STOP	00006270
5001	FORMAT(20A4)	00006280
5002	FORMAT(I4,I6,2I4)	00006290
5003	FORMAT(E10.0,6I4,2E10.0,2I4,E10.0)	00006300
5004	FORMAT(2I4,E10.0)	00006310
5005	FORMAT(3E10.0,I4)	00006320
5006	FORMAT(6E10.0)	00006330
5007	FORMAT(F10.0,3I4,4F10.0)	00006340
5008	FORMAT(8E10.0)	00006350
5009	FORMAT(E10.0,66X,A4)	00006360
5010	FORMAT(6E10.0,I4)	00006370
6001	FORMAT(34H11NCOMPLETE INPUT SET, JOB ABENDED)	00006380

6019	FORMAT(35HOLIMIT LOAD FRACTURE OCCURS IN THE ,I6,7H BLOCK ,	00006390
1	I4,12H STEP AFTER ,1PE12.3,7H CYCLES)	00006400
6020	FORMAT(10HONO GROWTH )	00006410
6021	FORMAT(28H1                      ITERATION RESULTS ,//49X,	00006420
1	11HPERCENT OF,//20H THICKNESS                      A,11X,1HC,9X,	00006430
2	20HLIFE      REQUIRED LIFE,//)	00006440
6022	FORMAT(1P4E12.3,0PF9.2)	00006450
6024	FORMAT(1H0,18HNKTMX OUT OF RANGE)	00006460
6100	FORMAT(1H0,35HX OR Y INPUT NOT IN ASCENDING ORDER)	00006470
6110	FORMAT(1H0,19HMORE THAN 25 X OR Y)	00006480
6120	FORMAT(1H0,'INCORRECT VALUE FOR ITERP = ',I4)	00006490
6130	FORMAT(1H0,'INCORRECT VALUE FOR KTYPE = ',I4)	00006500
6140	FORMAT(1H0,20HMORE THAN 10 D OR CR)	00006510
6150	FORMAT(1H0,	00006520
1	55HPLOT REQUESTED BUT FREQUENCY OF DATA POINTS NOT DEFINED)	00006530
6160	FORMAT(1H0,23HCALCULATED LIFE IS ZERO,//1H ,	00006540
1	27HITERATIONS CAN NOT PROCEED )	00006550
7000	FORMAT(4HDATA,1P3E12.3)	00006560
7010	FORMAT(4HTITL,4X,15A4,1PE12.3)	00006570
7020	FORMAT(4HHDRS)	00006580
7030	FORMAT(4HHDR1,/4HHDR2,/4HHDR3)	00006590
7040	FORMAT(4HHDR1,5X,14HCRITICAL K AT ,2A4,8HEXCEEDED,/4HHDR2,I6,	00006600
1	6H BLOCK,I5,5H STEP,1PE10.3,6H CYCLE,/4HHDR3,8X,	00006610
2	14HTOTAL CYCLES =,E10.3)	00006620
7050	FORMAT(4HHDR4,11X,11HTHICKNESS =,1PE10.3,/4HHDR5,18X,4HA0 =,	00006630
1	E10.3,/4HHDR6,18X,4HCC =,E10.3)	00006640
7060	FORMAT(4HHDR4,/4HHDR5,/4HHDR6)	00006650
7070	FORMAT(4HHDR1,3X,25HFRACTURE OCCURRED DURING ,3A4,/4HHDR2,I6,	00006660
1	6H BLOCK,I5,5H STEP,1PE10.3,6H CYCLE,/4HHDR3,8X,	00006670
2	14HTOTAL CYCLES =,E10.3)	00006680
8002	FORMAT(4H1RUN,I4,3H OF,I4,5H RUNS,10X,20A4,/16HLOAD INPUT DATA)	00006690
8003	FORMAT(1H-,5X,15HSTRESS FACTOR ,1PE12.3,/1H ,5X,	00006700
115H	LIMIT STRESS ,E12.3,/1H0,5X,	00006710
262H	STEP      MAX STRESS      MIN STRESS      UNITS(CYCLES)      MATERIAL TYPE,	00006720
3//)		00006730
8004	FORMAT(1H ,4X,I4,2X,1PE12.3,E13.3,2X,E12.3,8X,I4)	00006740
8005	FORMAT(1H-,19HGEOMETRY INPUT DATA,/1H0,5X,20HCRACK TYPE	00006750
1	2A4,I4,/1H ,5X,20HWIDTH                      ,1PE12.3,	00006760
2//1H	,5X,20HADDITIONAL DIMENSION,E12.3,	00006770
3//1H	,5X,20HRADIUS/NOTCH DEPTH ,E12.3,	00006780
4//1H	,5X,20HTHICKNESS                      ,E12.3)	00006790
8006	FORMAT(1H ,5X,20HCRACK DEPTH                      ,1PE12.3)	00006800
8007	FORMAT(1H ,5X,20HHALF CRACK LENGTH                      ,1PE12.3)	00006810
8008	FORMAT(1H-,19H MATERIAL INPUT DATA,/1H0,58X,8HCRITICAL,10X,	00006820
1	9HTHRESHOLD,9X,8HCRITICAL,10X,9HTHRESHOLD,/1H ,5X,	00006830
256H	MATERIAL      YIELD      GROWTH      RETARDATION STRESS ,	00006840
363H	INTENSITY STRESS INTENSITY STRESS INTENSITY STRESS INTENSITY	00006850
4,/1H	,7X,42HTYPE                      STRENGTH                      EQUATION                      MODEL,9X,	00006860
59H	(SURFACE),9X,9H(SURFACE),10X,7H(DEPTH),11X,7H(DEPTH),/)	00006870
8009	FORMAT(1H ,6X,I4,4X,1PE12.3,5X,I4,8X,I4,8X,E12.3,3(6X,E12.3))	00006880
8010	FORMAT(1H0,21X,14H-----,18HEQUATION CONSTANTS,	00006890
114H-----	,/1H ,37H CONSTANT MATERIAL      CRACK GROWTH ,	00006900
228H	RATE                      RETARDATION MODEL,/1H ,17H NUMBER      TYPE,6X,	00006910
342H	SURFACE      DEPTH      SURFACE      DEPTH)	00006920
8011	FORMAT(1H ,2X,I4,6X,I4,3X,1P4E12.3)	00006930
8012	FORMAT(1H-,20HITERATION PARAMETERS,/1H0,5X,	00006940
1	20HDESIGN LIFE                      ,1PE12.3,/1H ,5X,	00006950
2	20HCONVERGENCE EXPONENT,E12.3,/1H ,5X,	00006960
3	20HITERATION NUMBER                      ,8X,I4,/1H ,5X,	00006970
4	20HITERATION TYPE                      ,8X,I4)	00006980



8013	FORMAT(1H-,18PITERATIONS STOPPED,/1H ,	00006990
1	33HLAST PERCENTAGE LIFE IS INCORRECT,	00007000
2	/1H ,22HND GROWTH HAS OCCURRED)	00007010
8014	FORMAT(1HC,10H TABLE ,I4,': BETA C')	00007020
8015	FORMAT(1H0,12X,4H A=,7(1PE11.3,4X),E11.3)	00007030
8016	FORMAT(1H ,2HC=,1PF10.3,8E15.3)	00007040
8017	FORMAT(1H0,10H TABLE ,I4,': BETA A')	00007050
8018	FORMAT(1H-,16HPROOF INPUT DATA,/1H0,5X,10HPROOF TYPE,9X,I4,	00007060
1	7X,4HLOWE,A4,1PE12.3,/1H ,5X,5HPROOF,6X,E12.3,7X,4HUPPE,A4,	00007070
2	E12.3,/1H ,5X,11PKC PROOF ,E12.3,7X,2A4,E12.3,/1H ,5X,	00007080
3	11HKA PROOF ,E12.3,7X,16HITERATION LIMIT ,14)	00007090
8019	FORMAT(1HC,5X,13HMATERIAL TYPE,I4,5X,5HTABLE,I4)	00007100
8020	FORMAT(1H0,14X,4H RE=,7(1PE11.3,4X),E11.3)	00007110
8021	FORMAT(1H ,4HDKE=,1PF10.3,8E15.3)	00007120
	END	00007130

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SUBROUTINE PROOF(AO,CO,XLOW,XUP,IEND,NPROOF)	00000010
COMMON X(12,25),Y(12,25),TABLE(12,25,25),FIXED,KCPRF,KAPRF,	00000020
1 PROOFX,NKTMX,NCX(12),NOY(12),NTAB(10),IPL0T,IFAIL,CUMSUM,PCYC(2)	00000030
REAL KAPRF,KCPRF	00000040
EXTERNAL FCT1,FCT2,FCT3,FCT4,FCT5,FCT6,FCT7	00000050
IF (IEND.NE.0) GO TO 10	00000060
IEND=100	00000070
10 GO TO (100,200,300,400),NPROOF	00000080
C	00000090
100 CONTINUE	00000100
CALL RTMI(A1,ZERO,FCT1,XLOW,XUP,.001,IEND,IER)	00000110
CALL MESS1(IER,A1,XUP)	00000120
IERC=IER	00000130
CALL RTMI(A2,ZERO,FCT2,XLOW,XUP,.001,IEND,IER)	00000140
CALL MESS2(IER,A2,XUP)	00000150
IERC=IERC*IER	00000160
IF (IERC.NE.0) GO TO 2000	00000170
AO=AMINI(A1,A2)	00000180
CO=AO/FIXED	00000190
GO TO 1000	00000200
200 CONTINUE	00000210
CALL RTMI(CO,ZERO,FCT3,XLOW,XUP,.001,IEND,IER)	00000220
CALL MESS2(IER,CO,XUP)	00000230
IF (IER.NE.0) GO TO 2000	00000240
GO TO 1000	00000250
300 CONTINUE	00000260
CALL RTMI(A1,ZERO,FCT4,XLOW,XUP,.001,IEND,IER)	00000270
CALL MESS1(IER,A1,XUP)	00000280
IERC=IER	00000290
CALL RTMI(A2,ZERO,FCT5,XLOW,XUP,.001,IEND,IER)	00000300
CALL MESS2(IER,A2,XUP)	00000310
IERC=IERC*IER	00000320
IF (IERC.NE.0) GO TO 2000	00000330
AO=AMINI(A1,A2)	00000340
CO=FIXED	00000350
GO TO 1000	00000360
400 CONTINUE	00000370
CALL RTMI(C1,ZERO,FCT6,XLOW,XUP,.001,IEND,IER)	00000380
CALL MESS1(IER,C1,XUP)	00000390
IERC=IER	00000400
CALL RTMI(C2,ZERO,FCT7,XLOW,XUP,.001,IEND,IER)	00000410
CALL MESS2(IER,C2,XUP)	00000420
IERC=IERC*IER	00000430
IF (IERC.NE.0) GO TO 2000	00000440
CO=AMINI(C1,C2)	00000450
AO=FIXED	00000460
1000 RETURN	00000470
2000 STOP	00000480
END	00000490



SUBROUTINE MESS1( IER,X,XUP)	00000010
IF (IER.NE.1) GO TO 600	00000020
X=XUP	00000030
WRITE(6,6010)	00000040
GO TO 700	00000050
600 IF (IER.NE.2) GO TO 700	00000060
X=XUP	00000070
WRITE(6,6020)	00000080
700 RETURN	00000090
6010 FORMAT(1H0,45HPROOF LOAD CALCULATION AT DEPTH HAS NOT CONVERGED)	00000100
6020 FORMAT(1H0,39HBOUNDS ON VARIABLE ARE NOT APPROPRIATE.,/1H ,	00000110
1 54HEITHER CRITICAL STRESS INTENSITY AT DEPTH IS LESS THAN,	00000120
2 22H KPROOF AT LOWER BOUND,/1H ,26H OR GREATER THAN KPROOF,	00000130
3 15H AT UPPER BOUND)	00000140
END	00000150

SUBROUTINE MESS2(IER,X,XUP)	00000160
IF (IER.NE.1) GO TO 600	00000170
X=XUP	00000180
WRITE(6,6010)	00000190
GO TO 700	00000200
600 IF (IER.NE.2) GO TO 700	00000210
X=XUP	00000220
WRITE(6,6020)	00000230
700 RETURN	00000240
6010 FORMAT(IH0,51HPROOF LOAD CALCULATION AT SURFACE HAS NOT CONVERGED)	00000250
6020 FORMAT(IH0,39HBOUNDS ON VARIABLE ARE NOT APPROPRIATE.,/IH ,	00000260
1 56HEITHER CRITICAL STRESS INTENSITY AT SURFACE IS LESS THAN,	00000270
2 22H KPROOF AT LOWER BOUND,/IH ,26H OR GREATER THAN KPROOF,	00000280
3 15H AT UPPER BOUND)	00000290
END	00000300



SUBROUTINE RTMI(X,F,FCT,XLI,XRI,EPS,IFND,IER)

RTMI 560

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RTMI 20

RTMI 30

RTMI 40

RTMI 50

RTMI 60

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RTMI 590

RTMI 600

SUBROUTINE RTMI

PURPOSE

TO SOLVE GENERAL NONLINEAR EQUATIONS OF THE FORM  $FCT(X)=0$   
BY MEANS OF MUELLER-S ITERATION METHOD.

USAGE

CALL RTMI (X,F,FCT,XLI,XRI,EPS,IFND,IER)  
PARAMETER FCT REQUIRES AN EXTERNAL STATEMENT.

DESCRIPTION OF PARAMETERS

X - RESULTANT ROOT OF EQUATION  $FCT(X)=0$ .  
F - RESULTANT FUNCTION VALUE AT ROOT X.  
FCT - NAME OF THE EXTERNAL FUNCTION SUBPROGRAM USED.  
XLI - INPUT VALUE WHICH SPECIFIES THE INITIAL LEFT BOUND  
OF THE ROOT X.  
XRI - INPUT VALUE WHICH SPECIFIES THE INITIAL RIGHT BOUND  
OF THE ROOT X.  
EPS - INPUT VALUE WHICH SPECIFIES THE UPPER BOUND OF THE  
ERROR OF RESULT X.  
IFND - MAXIMUM NUMBER OF ITERATION STEPS SPECIFIED.  
IER - RESULTANT ERROR PARAMETER CODED AS FOLLOWS  
IER=0 - NO ERROR,  
IER=1 - NO CONVERGENCE AFTER IFND ITERATION STEPS  
FOLLOWED BY IFND SUCCESSIVE STEPS OF  
BISECTION,  
IER=2 - BASIC ASSUMPTION  $FCT(XLI)*FCT(XRI)$  LESS  
THAN OR EQUAL TO ZERO IS NOT SATISFIED.

REMARKS

THE PROCEDURE ASSUMES THAT FUNCTION VALUES AT INITIAL  
BOUNDS XLI AND XRI HAVE NOT THE SAME SIGN. IF THIS BASIC  
ASSUMPTION IS NOT SATISFIED BY INPUT VALUES XLI AND XRI, THE  
PROCEDURE IS BYPASSED AND GIVES THE ERROR MESSAGE IER=2.

SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED

THE EXTERNAL FUNCTION SUBPROGRAM FCT(X) MUST BE FURNISHED  
BY THE USER.

METHOD

SOLUTION OF EQUATION  $FCT(X)=0$  IS DONE BY MEANS OF MUELLER-S  
ITERATION METHOD OF SUCCESSIVE BISECTIONS AND INVERSE  
PARABOLIC INTERPOLATION, WHICH STARTS AT THE INITIAL BOUNDS  
XLI AND XRI. CONVERGENCE IS QUADRATIC IF THE DERIVATIVE OF  
 $FCT(X)$  AT ROOT X IS NOT EQUAL TO ZERO. ONE ITERATION STEP  
REQUIRES TWO EVALUATIONS OF FCT(X). FOR TEST ON SATISFACTORY  
ACCURACY SEE FORMULAE (3,4) OF MATHEMATICAL DESCRIPTION.  
FOR REFERENCE, SEE G. K. KRISTIANSEN, ZERO OF ARBITRARY  
FUNCTION, BIT, VOL. 3 (1963), PP.205-206.

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PREPARE ITERATION  
IER=0

XL=XLI	RTMI 610
XR=XRI	RTMI 620
X=XL	RTMI 630
TOL=X	RTMI 640
F=FCT(TOL)	RTMI 650
IF(F)1,16,1	RTMI 660
1 FL=F	RTMI 670
X=XR	RTMI 680
TOL=X	RTMI 690
F=FCT(TOL)	RTMI 700
IF(F)2,16,2	RTMI 710
2 FR=F	RTMI 720
IF(SIGN(1.,FL)+SIGN(1.,FR))25,3,25	RTMI 730
C	RTMI 740
C BASIC ASSUMPTION FL*FR LESS THAN 0 IS SATISFIED.	RTMI 750
C GENERATE TOLERANCE FOR FUNCTION VALUES.	RTMI 760
3 I=0	RTMI 770
TOLF=100.*EPS	RTMI 780
C	RTMI 790
C	RTMI 800
C START ITERATION LOOP	RTMI 810
4 I=I+1	RTMI 820
C	RTMI 830
C START BISECTION LOOP	RTMI 840
DO 13 K=1,IEND	RTMI 850
X=.5*(XL+XR)	RTMI 860
TOL=X	RTMI 870
F=FCT(TOL)	RTMI 880
IF(F)5,16,5	RTMI 890
5 IF(SIGN(1.,F)+SIGN(1.,FR))7,6,7	RTMI 900
C	RTMI 910
C INTERCHANGE XL AND XR IN ORDER TO GET THE SAME SIGN IN F AND FR	RTMI 920
6 TOL=XL	RTMI 930
XL=XR	RTMI 940
XR=TOL	RTMI 950
TOL=FL	RTMI 960
FL=FR	RTMI 970
FR=TOL	RTMI 980
7 TOL=F-FL	RTMI 990
A=F*TOL	RTMI1000
A=A+A	RTMI1010
IF(A-FR*(FR-FL))8,9,9	RTMI1020
8 IF(I-IEND)17,17,9	RTMI1030
9 XR=X	RTMI1040
FR=F	RTMI1050
C	RTMI1060
C TEST ON SATISFACTORY ACCURACY IN BISECTION LOOP	RTMI1070
TOL=EPS	RTMI1080
A=ABS(XR)	RTMI1090
IF(A-1.)11,11,10	RTMI1100
10 TOL=TOL*A	RTMI1110
11 IF(ABS(XR-XL)-TOL)12,12,13	RTMI1120
12 IF(ABS(FR-FL)-TOLF)14,14,13	RTMI1130
13 CONTINUE	RTMI1140
C	RTMI1150
C END OF BISECTION LOOP	RTMI1160
C	RTMI1170
C NO CONVERGENCE AFTER IEND ITERATION STEPS FOLLOWED BY IEND	RTMI1180
C SUCCESSIVE STEPS OF BISECTION OR STEADILY INCREASING FUNCTION	RTMI1190
C VALUES AT RIGHT BOUNDS. ERROR RETURN.	RTMI1200
IER=1	



14	IF (ABS(FR)-ABS(FL))16,16,15	RTM1121C
15	X=XL	RTM1122C
	F=FL	RTM1123C
16	RETURN	RTM1124C
C		RTM1125C
C	COMPUTATION OF ITERATED X-VALUE BY INVERSE PARABOLIC INTERPOLATION	RTM1126C
17	A=FR-F	RTM1127C
	DX=(X-XL)*FL*(1.+F*(A-TOL)/(A*(FR-FL)))/TOL	RTM1128C
	XM=X	RTM1129C
	FM=F	RTM1130C
	X=XL-DX	RTM1131C
	TOL=X	RTM1132C
	F=FCT(TOL)	RTM1133C
	IF(F)18,16,18	RTM1134C
C		RTM1135C
C	TEST ON SATISFACTORY ACCURACY IN ITERATION LOOP	RTM1136C
18	TOL=EPS	RTM1137C
	A=ABS(X)	RTM1138C
	IF(A-1.)20,20,19	RTM1139C
19	TOL=TOL*A	RTM1140C
20	IF (ABS(DX)-TOL)21,21,22	RTM1141C
21	IF (ABS(F)-TOLF)16,16,22	RTM1142C
C		RTM1143C
C	PREPARATION OF NEXT BISECTION LOOP	RTM1144C
22	IF (SIGN(1.,F)+SIGN(1.,FL))24,23,24	RTM1145C
23	XR=X	RTM1146C
	FR=F	RTM1147C
	GO TO 4	RTM1148C
24	XL=X	RTM1149C
	FL=F	RTM1150C
	XR=XM	RTM1151C
	FR=FM	RTM1152C
	GO TO 4	RTM1153C
C	END OF ITERATION LOOP	RTM1154C
C		RTM1155C
C		RTM1156C
C	ERROR RETURN IN CASE OF WRONG INPUT DATA	RTM1157C
25	IER=2	RTM1158C
	RETURN	RTM1159C
	END	RTM1160C

FUNCTION FCT1(AF)	00000010
COMMON X(12,25),Y(12,25),TABLE(12,25,25),FIXED,KCPRF,KAPRF,	00000020
1 PROOFX,NKTMX,NOX(12),NOY(12),NTAB(10),IPLOT,IFAIL,CUMSUM,PCYC(2)	00000030
COMMON A,AP(2),ALIM,AOL(2),C,CB,CLIM,CR(2,10,10),CO,CUME,	00000040
1 CUMELM,CIB1,D(2,10,10),DK,DKE,DXDX,FA,FC,H,INC,KCL,KC1,KOL,	00000050
2 KOA,KOC,KCRA,KCRC,KMAX,OA,OC,PI,R,RAD,RE,RYOL(2),ROL(2),	00000060
3 SIG,SIGLM,SIGY,SIGYS(10),SMIN(422),SMAX(422),TH,	00000070
4 UNIT(422),W,DCTMP,DELTMP,DXTMP,	00000080
5 ALOWN,BLOCK,FLAG1,I,ICD(2),ICK(2),ICR(2),IBLOCK,IFIRST,IPRN(4),	00000090
6 ISTEP,ITRANS,J,K TYPE(2),NC,NEQ(10),NR,NRET(10),TYPE,TITL	00000100
INTEGER ALOWN,BLOCK,FLAG1,TYPE(422),TITL(20)	00000110
REAL KCL,KC1,KOL,KOA(10),KOC(10),KCRA(10),KCRC(10),KMAX,INC	00000120
REAL KCPRF,KAPRF	00000130
A=AF	00000140
C=A/FIXED	00000150
CALL KANAL	00000160
FCT1=-KAPRF+FA*PROOFX	00000170
RETURN	00000180
END	00000190



FUNCTION FCT2(AF)	00000200
COMMON X(12,25),Y(12,25),TABLE(12,25,25),FIXED,KCPRF,KAPRF,	00000210
1 PROOFX,NKTMX,NOX(12),NOY(12),NTAB(10),IPLOT,IFAIL,CUMSUM,PCYC(2)	00000220
COMMON A,AP(2),ALIM,AGL(2),C,CB,CLIM,CR(2,10,10),CO,CUME,	00000230
1 CUMELM,CIB1,D(2,10,10),DK,DKE,DXDX,FA,FC,H,INC,KCL,KC1,KOL,	00000240
2 KOA,KOC,KCRA,KCRC,KMAX,OA,OC,P1,P,RAD,RE,RVOL(2),ROL(2),	00000250
3 SIG,SIGLM,SIGY,SIGYS(10),SMIN(422),SMAX(422),TH,	00000260
4 UNIT(422),W,DCTMP,DELTMP,DXTMP,	00000270
5 ALOWN,BLOCK,FLAG1,I,ICD(2),ICK(2),ICR(2),IBLOCK,IFIRST,IPRN(4),	00000280
6 ISTEP,ITRANS,J,KTYPE(2),NC,NEQ(10),NR,NRET(10),TYPE,TITL	00000290
INTEGER ALOWN,BLOCK,FLAG1,TYPE(422),TITL(20)	00000300
REAL KCL,KC1,KOL,KGA(10),KOC(10),KCPA(10),KCRC(10),KMAX,INC	00000310
REAL KCPRF,KAPRF	00000320
A=AF	00000330
C=A/FIXED	00000340
CALL KANAL	00000350
FCT2=-KCPRF+FC*PROOFX	00000360
RETURN	00000370
END	00000380

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FUNCTION FCT3(CF)	00000390
COMMON X(12,25),Y(12,25),TABLE(12,25,25),FIXED,KCPRF,KAPRF,	00000400
1 PROOFX,NKTMX,NOX(12),NOY(12),NTAB(10),IPLOT,IFAIL,CUMSUM,PCYC(2)	00000410
COMMON A,AP(2),ALIM,AOL(2),C,CB,CLIM,CR(2,10,10),CO,CUME,	00000420
1 CUMELM,C1B1,D(2,10,10),DK,DKE,DXDX,FA,FC,H,INC,KCL,KC1,KOL,	00000430
2 KOA,KOC,KCRA,KCRC,KMAX,OA,OC,P1,R,RAD,RE,RVOL(2),ROL(2),	00000440
3 SIG,SIGLM,SIGY,SIGYS(10),SMIN(422),SMAX(422),TH,	00000450
4 UNIT(422),W,DCTMP,DELTMP,DXTMP,	00000460
5 ALOWN,BLOCK,FLAG1,I,ICD(2),ICK(2),ICR(2),IBLOCK,IFIRST,IPRN(4),	00000470
6 ISTEP,ITRANS,J,KTYPE(2),NC,NEG(10),NR,NRET(10),TYPE,TITL	00000480
INTEGER ALOWN,BLOCK,FLAG1,TYPE(422),TITL(20)	00000490
REAL KCL,KC1,KOL,KOA(10),KOC(10),KCRA(10),KCRC(10),KMAX,INC	00000500
REAL KCPRF,KAPRF	00000510
C=CF	00000520
CALL KANAL	00000530
FCT3=-KCPRF+FC*PROOFX	00000540
RETURN	00000550
END	00000560



FUNCTION FCT4(AF)	00000570
COMMON X(12,25),Y(12,25),TABLE(12,25,25),FIXED,KCPRF,KAPRF,	00000580
1 PROOFX,NKTMX,NOX(12),NOY(12),NTAB(10),IPLOT,IFAIL,CUMSUM,PCYC(2)	00000590
COMMON A,AP(2),ALIM,AOL(2),C,CB,CLIM,CR(2,10,10),CO,CUMF,	00000600
1 CUMELM,C1B1,D(2,10,10),DK,DKE,DXDX,FA,FC,H,INC,KCL,KC1,KOL,	00000610
2 KOA,KOC,KCRA,KCRC,KMAX,CA,OC,PI,R,RAD,RE,RVOL(2),ROL(2),	00000620
3 SIG,SIGLM,SIGY,SIGYS(10),SMIN(422),SMAX(422),TH,	00000630
4 UNIT(422),W,DCTMP,DELTMP,DXTMP,	00000640
5 ALOWN,BLOCK,FLAG1,I,ICD(2),ICK(2),ICR(2),IBLOCK,IFIRST,IPRN(4),	00000650
6 ISTEP,ITRANS,J,KTYPE(2),NC,NEQ(10),NR,NRET(10),TYPE,TITL	00000660
INTEGER ALOWN,BLOCK,FLAG1,TYPE(422),TITL(20)	00000670
REAL KCL,KC1,KOL,KOA(10),KOC(10),KCRA(10),KCRC(10),KMAX,INC	00000680
REAL KCPRF,KAPRF	00000690
A=AF	00000700
C=FIXED	00000710
CALL KANAL	00000720
FCT4=-KAPRF+FA*PROOFX	00000730
RETURN	00000740
END	00000750

FUNCTION FCT5(AF)	00000760
COMMON X(12,25),Y(12,25),TABLE(12,25,25),FIXED,KCPRF,KAPRF,	00000770
1 PROOFX,NKTMX,NOX(12),NOY(12),NTAB(10),IPLOT,IFAIL,CUMSUM,PCYC(2)	00000780
COMMON A,AP(2),ALIM,AOL(2),C,CB,CLIM,CR(2,10,10),CO,CUME,	00000790
1 CUMELM,CIB1,D(2,10,10),DK,DKE,DXDX,FA,FC,H,INC,KCL,KC1,KOL,	00000800
2 KOA,KOC,KCRA,KCRC,KMAX,OA,OC,PI,R,RAD,RE,RYOL(2),ROL(2),	00000810
3 SIG,SIGLM,SIGY,SIGYS(10),SMIN(422),SMAX(422),TH,	00000820
4 UNIT(422),W,DCTMP,DELTMP,DXTMP,	00000830
5 ALOWN,BLOCK,FLAG1,I,ICD(2),ICK(2),ICR(2),IBLOCK,IFIRST,IPRN(4),	00000840
6 ISTEP,ITRANS,J,KTYPE(2),NC,NEQ(10),NR,NRET(10),TYPE,TITL	00000850
INTEGER ALOWN,BLOCK,FLAG1,TYPE(422),TITL(20)	00000860
REAL KCL,KC1,KOL,KOA(10),KOC(10),KCRA(10),KCRC(10),KMAX,INC	00000870
REAL KCPRF,KAPRF	00000880
A=AF	00000890
C=FIXED	00000900
CALL KANAL	00000910
FCT5=-KCPRF+FC*PROOFX	00000920
RETURN	00000930
END	00000940



FUNCTION FCT6(CF)	00000950
COMMON X(12,25),Y(12,25),TABLE(12,25,25),FIXED,KCPRF,KAPRF,	00000960
1 PROOFX,NKTMX,NOX(12),NOY(12),NTAB(10),IPLOT,IFAIL,CUMSUM,PCYC(2)	00000970
COMMON A,AP(2),ALIM,AOL(2),C,CB,CLIM,CR(2,10,10),CO,CUME,	00000980
1 CUMELM,C1B1,D(2,10,10),DK,DKE,DXDX,FA,FC,H,INC,KCL,KC1,KOL,	00000990
2 KOA,KOC,KCRA,KCRC,KMAX,OA,OC,PI,R,RAD,RE,RYGL(2),ROL(2),	00001000
3 SIG,SIGLM,SIGY,SIGYS(10),SPIN(422),SMAX(422),TH,	00001010
4 UNIT(422),W,DCTMP,DELTMP,DXTMP,	00001020
5 ALOWN,BLOCK,FLAG1,I,ICD(2),ICK(2),ICR(2),IBLOCK,IFIRST,IPRN(4),	00001030
6 ISTEP,ITRANS,J,KTYPE(2),MC,NEQ(10),NR,NRET(10),TYPE,TITL	00001040
INTEGER ALOWN,BLOCK,FLAG1,TYPE(422),TITL(20)	00001050
REAL KCL,KC1,KOL,KOA(10),KOC(10),KCRA(10),KCRC(10),KMAX,INC	00001060
REAL KCPRF,KAPRF	00001070
C=CF	00001080
A=FIXED	00001090
CALL KANAL	00001100
FCT6=-KAPRF+FA*PROOFX	00001110
RETURN	00001120
END	00001130

FUNCTION FCT7(CF)	00001140
COMMON X(12,25),Y(12,25),TABLE(12,25,25),FIXED,KCPRF,KAPRF,	00001150
1 PROOFX,NKTMX,NOX(12),NOY(12),NTAB(10),IPLOT,IFAIL,CUMSUM,PCYC(2)	00001160
COMMON A,AP(2),ALIM,AOL(2),C,CB,CLIM,CR(2,10,10),CO,CUMF,	00001170
1 CUMELM,C1B1,D(2,10,10),DK,DKE,DXDX,FA,FC,H,INC,KCL,KC1,KOL,	00001180
2 KOA,KOC,KCRA,KCRC,KMAX,OA,OC,PI,R,RAD,RE,RYOL(2),ROL(2),	00001190
3 SIG,SIGLM,SIGY,SIGYS(10),SMIN(422),SMAX(422),TH,	00001200
4 UNIT(422),W,DCTMP,DELTMP,DXTMP,	00001210
5 ALOWN,BLOCK,FLAG1,I,ICD(2),ICK(2),ICR(2),IBLOCK,IFIRST,IPRN(4),	00001220
6 ISTEP,ITRANS,J,KTYPE(2),NC,NEQ(10),NR,NRET(10),TYPE,TITL	00001230
INTEGER ALOWN,BLOCK,FLAG1,TYPE(422),TITL(20)	00001240
REAL KCL,KC1,KOL,KOA(10),KOC(10),KCRA(10),KCRC(10),KMAX,INC	00001250
REAL KCPRF,KAPRF	00001260
C=CF	00001270
A=FIXED	00001280
CALL KANAL	00001290
FCT7=-KCPRF+FC*PROOFX	00001300
RETURN	00001310
END	00001320



SUBROUTINE PTCGRW	00000010
COMMON X(12,25),Y(12,25),TABLE(12,25,25),FIXED,KCPRF,KAPRF,	00000020
1 PROOFX,NKTMX,NOX(12),NDY(12),NTAB(10),IPLOT,IFAIL,CUMSUM,PCYC(2)	00000030
COMMON A,AP(2),ALIM,AOL(2),C,CB,CLIM,CR(2,10,10),CO,CUME,	00000040
1 CUMELM,C1B1,D(2,10,10),DK,DKE,DXDX,FA,FC,H,INC,KCL,KC1,KOL,	00000050
2 KOA,KOC,KCRA,KCRC,KMAX,OA,OC,PI,R,RAD,RE,RYOL(2),ROL(2),	00000060
3 SIG,SIGLM,SIGY,SIGYS(10),SMIN(422),SMAX(422),TH,	00000070
4 UNIT(422),W,DCTMP,DELTMP,DXTMP,	00000080
5 ALOWN,BLOCK,FLAG1,I,ICK(2),ICK(2),ICK(2),IBLOCK,IFIRST,IPRN(4),	00000090
6 ISTEP,ITRANS,J,KTYPE(2),NC,NEQ(10),NR,NRET(10),TYPE,TITL	00000100
INTEGER ALOWN,BLOCK,FLAG1,TYPE(422),TITL(20)	00000110
REAL KCL,KC1,KOL,KOA(10),KOC(10),KCRA(10),KCRC(10),KMAX	00000120
PEAL INC,KA,KC,KAPRF,KCPRF	00000130
K=0	00000140
IFIRST=1	00000150
J=TYPE(I)	00000160
1025 DEL=INC*A	00000170
IF (NRET(J)) 1050,1050,1030	00000180
1030 IF (ABS(RYOL(2))-1.0001) 1050,1050,1038	00000190
1038 IF (DEL-.1*RYOL(2)) 1050,1050,1040	00000200
1040 DEL=.1*RYOL(2)	00000210
1050 A=A+DEL	00000220
KI=KTYPE(2)	00000230
GO TO (1054,1054,1054,1054,1056,1056,1054,1054,1054,1056,1056,	00000240
1 1054,1054,1056,1056,1054,1056), KI	00000250
C	00000260
C NOT INTERNAL TYPE CRACK	00000270
C	00000280
1054 TEMP=TH	00000290
GO TO 1058	00000300
C	00000310
C INTERNAL TYPE CRACK	00000320
C	00000330
1056 TEMP=TH/2.	00000340
1058 IF (ABS(A-DEL-TEMP)-1.E-6) 1060,1060,1070	00000350
1060 IF (KTYPE(2).EQ.7) GO TO 1065	00000360
KTYPE(1)=2	00000370
CALL TRANS	00000380
RETURN	00000390
1065 WRITE(6,6110)	00000400
ICR(1)=-1	00000410
CUMSUM=CUMSUM+CUME	00000420
RETURN	00000430
1070 IF (A-TEMP) 1090,1090,1080	00000440
1080 DEL=TEMP-A+DEL	00000450
A=TEMP	00000460
1090 SIGY=SIGYS(J)	00000470
IF (FLAG1) 1130,1100,1130	00000480
1100 R=0	00000490
SIG=SIGLM	00000500
CALL KANAL	00000510
IF (SIGLM*FA-KCRA(J)) 1110,1110,1120	00000520
1110 IF (SIGLM*FC-KCRC(J)) 1130,1130,1120	00000530
1120 FLAG1=1	00000540
ALIM=A	00000550
CLIM=C	00000560
IBLOCK=BLOCK	00000570
ISTEP=I	00000580
CUMELM=CUME	00000590
1130 A=A-DEL/2	00000600

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SIG=SMAX(I)	00000610
R=SMIN(I)/SMAX(I)	00000620
CALL KANAL	00000630
A=A-DEL/2	00000640
KA=FA*SIG	00000650
KC=FC*SIG	00000660
DKA=(1-R)*KA	00000670
DKC=(1-R)*KC	00000680
IF (KA-KCRA(J)) 1140,1140,1150	00000690
1140 IF (KC-KCRC(J)) 1160,1160,1153	00000700
1150 IF (FLAG1) 1152,1152,1151	00000710
1151 WRITE(6,6019) IBLOCK,ISTEP,CUMELM	00000720
1152 WRITE (6,6002) BLOCK,I,CUME	00000730
IFAIL=1	00000740
CUMSUM=CUMSUM+CUME	00000750
ICR(I)=-1	00000760
RETURN	00000770
1153 IF (FLAG1) 1155,1155,1154	00000780
1154 WRITE(6,6019) IBLOCK,ISTEP,CUMELM	00000790
1155 WRITE (6,6003) BLOCK,I,CUME	00000800
IFAIL=2	00000810
CUMSUM=CUMSUM+CUME	00000820
ICR(I)=-1	00000830
RETURN	00000840
1160 IF (KOA(J)-DKA) 1180,1170,1170	00000850
1170 DADX=0	00000860
IF (KOC(J)-DKC) 1190,1172,1172	00000870
1172 K=1	00000880
DCDX=0	00000890
GO TO 1211	00000900
1180 KMAX=KA	00000910
DK=DKA	00000920
NC=2	00000930
CALL DAMAGE	00000940
IF (DXDX) 1191,1182,1182	00000950
1182 CONTINUE	00000960
DADX=DXDX	00000970
IF (KOC(J)-DKC) 1190,1200,1200	00000980
1190 KMAX=KC	00000990
DK=DKC	00001000
NC=1	00001010
CALL DAMAGE	00001020
IF (DXDX) 1191,1192,1192	00001030
1191 ICR(I)=-1	00001040
CUMSUM=CUMSUM+CUME	00001050
WRITE(6,6100)	00001060
RETURN	00001070
1192 CONTINUE	00001080
DCDX=DXDX	00001090
GO TO 1210	00001100
1200 DCDX=0	00001110
1210 AVAIL=UNIT(I)-CUME	00001120
IF (A*C*DCDX*DADX.EQ.0) GO TO 1211	00001121
ADJ=5.*DADX/A/(DCDX/C)	00001122
IF (ADJ.GE.1.) GO TO 1211	00001123
DEL=ADJ*DEL	00001124
1211 IF (IPRN(1)-IPRN(4)) 1201,1205,1205	00001130
1201 IF (IPRN(1)) 1202,1203,1203	00001140
1202 WRITE(6,8002) NR,TITL	00001150
WRITE(6,8003)	00001160



IPRN(1)=0	00001170
DELTMP=0.	00001180
DCTMP=0.	00001190
DXTMP=0.	00001200
1203 IF (IFIRST-1) 1205,1204,1205	00001210
1204 IFIRST=0	00001220
IPRN(1)=IPRN(1)+1	00001230
WRITE(6,8004) BLOCK,I,CUME,C,A,KC,KA,DCDX,DADX	00001240
IF (K) 5000,1205,5000	00001250
1205 CONTINUE	00001260
IF (ALOWN-1) 1230,1220,1230	00001270
1220 DX=1	00001280
DEL=DADX	00001290
DC=DCDX	00001300
GO TO 1260	00001310
1230 IF (DADX) 1235,1265,1235	00001320
1235 IF (DEL/DADX-AVAIL) 1250,1250,1240	00001330
1240 DELTMP=DELTMP+AVAIL*DADX	00001340
IF (A) 1241,1242,1241	00001350
1241 IF (DELTMP/A-1.E-4) 1244,1244,1242	00001360
1242 A=A+DELTMP	00001370
DELTMP=0.	00001380
1244 DCTMP=DCTMP+AVAIL*DCDX	00001390
IF (C) 1245,1246,1245	00001400
1245 IF (DCTMP/C-1.E-4) 5000,5000,1246	00001410
1246 C=C+DCTMP	00001420
DCTMP=0.	00001430
GO TO 5000	00001440
1250 DX=DEL/DADX	00001450
DC=DX*DCDX	00001460
GO TO 1260	00001470
1265 DC=INC*C	00001480
IF (RYOL(1)-1.E-4) 1258,1258,1256	00001490
1256 IF (NRET(J)) 1257,1259,1257	00001500
1257 DC=AMINI(.1*RYOL(1),DC)	00001510
1258 IF (DCDX) 5000,5000,1259	00001520
1259 DX=DC/DCDX	00001530
DEL=DX*DADX	00001540
1260 IF (DX-AVAIL) 1280,1280,1270	00001550
1270 DELTMP=DELTMP+AVAIL*DADX	00001560
IF (A) 1271,1272,1271	00001570
1271 IF (DELTMP/A-1.E-4) 1274,1274,1272	00001580
1272 A=A+DELTMP	00001590
DELTMP=0.	00001600
1274 DCTMP=DCTMP+AVAIL*DCDX	00001610
IF (C) 1275,1276,1275	00001620
1275 IF (DCTMP/C-1.E-4) 5000,5000,1276	00001630
1276 C=C+DCTMP	00001640
DCTMP=0.	00001650
GO TO 5000	00001660
1280 DELTMP=DELTMP+DEL	00001670
IF (A) 1281,1282,1281	00001680
1281 IF (DELTMP/A-1.E-4) 1284,1284,1282	00001690
1282 A=A+DELTMP	00001700
DELTMP=0.	00001710
1284 DCTMP=DCTMP+DC	00001720
IF (C) 1285,1286,1285	00001730
1285 IF (DCTMP/C-1.E-4) 1288,1288,1286	00001740
1286 C=C+DCTMP	00001750
DCTMP=0.	00001760

1288 DXTMP=DXTMP+DX	00001770
IF (IPLDT.NE.2) GO TO 1300	00001780
CUMTMP=CUMSUM+CUME	00001790
IF (CUMTMP.LT.PCYC(2)) GO TO 1300	00001800
WRITE(7,7000) A,C,CUMTMP	00001810
PCYC(2)=PCYC(2)+PCYC(1)	00001820
1300 IF (CUME) 1289,1290,1289	00001830
1289 IF (DXTMP/CUME-1.E-4) 1025,1025,1290	00001840
1290 CUME=CUME+DXTMP	00001850
DXTMP=0.	00001860
GO TO 1025	00001870
5000 CONTINUE	00001880
CUME=UNIT(I)	00001890
CUMSUM=CUMSUM+UNIT(I)	00001900
IF (IPLDT.NE.2) GO TO 5005	00001910
IF (CUMSUM.LT.PCYC(2)) GO TO 5005	00001920
WRITE(7,7000) A,C,CUMSUM	00001930
PCYC(2)=PCYC(2)+PCYC(1)	00001940
5005 IF (IPRN(1)-IPRN(4)) 5010,5020,5020	00001950
5010 IPRN(1) = IPRN(1)+1	00001960
WRITE(6,8005) BLOCK,I,CUME,C,A,KC,KA,DCDX,DADX	00001970
IF (IPLDT.NE.1) GO TO 5020	00001980
WRITE(7,7000) A,C,CUMSUM	00001990
5020 CONTINUE	00002000
RETURN	00002010
6002 FORMAT(45HOCRITICAL K AT DEPTH HAS BEEN EXCEEDED IN THE,I6,	00002020
1 14H BLOCK AND THE,I4,11H STEP AFTER,1PE12.3,7H CYCLES )	00002030
6003 FORMAT(47HOCRITICAL K AT SURFACE HAS BEEN EXCEEDED IN THE,I6,	00002040
1 14H BLOCK AND THE,I4,11H STEP AFTER,1PE12.3,7H CYCLES )	00002050
6019 FORMAT(35HOLIMIT LOAD FRACTURE OCCURS IN THE ,I6,7H BLOCK ,	00002060
1 I4,12H STEP AFTER ,1PE12.3,7H CYCLES)	00002070
6100 FORMAT(1H0,29HCRACK GROWTH RATE IS NEGATIVE,/1H ,	00002080
1 46HACCEPTABLE END OF LIFE IF FORMUN EQUATION USED)	00002090
6110 FORMAT(/1H0,46HCRACK IN TRANSITION. NEED TABLES FOR ANALYSIS.)	00002100
7000 FORMAT(4HDATA,1P3E12.3)	00002110
8002 FORMAT(5HIRUN ,I4,5X,20A4,/1H0,50X,26HCRACK IS A PART THRU CRACK,	00002120
1 /1H0,42X,12HHALE SURFACE,50X,7HSURFACE,9X,5HDEPTH)	00002130
8003 FORMAT(1H ,12X,45HBLOCK STEP CYCLES CRACK LENGTH ,	00002140
156HCRACK DEPTH KMAX-SURFACE KMAX-DEPTH GROWTH RATE,4X,	00002150
211HGROWTH RATE,/1H ,46X,4H(IN),11X,4H(IN),6X,13H(KSI ROOT-IN),2X,	00002160
313H(KSI ROOT-IN),4X,10H(IN/CYCLE),5X,10H(IN/CYCLE),//)	00002170
8004 FORMAT(10H ,I6,3X,I4,7(3X,1PE12.3))	00002180
8005 FORMAT(10H ,I6,3X,I4,7(3X,1PE12.3))	00002190
END	00002200



SUBROUTINE TRANS	00000010
COMMON X(12,25),Y(12,25),TABLE(12,25,25),FIXED,KCPRE,KAPRE,	00000020
1 PRODFX,NKTMX,NOX(12),NOY(12),NTAB(10),IPLT,IFAIL,CUMSUM,PCYC(2)	00000030
COMMON A,AP(2),ALIM,AOL(2),C,CB,CLIM,CR(2,10,10),CO,CUME,	00000040
1 CUMELM,CIB1,D(2,10,10),DK,DKE,DXDX,FA,FC,H,INC,KCL,KC1,KOL,	00000050
2 KOA,KOC,KCRA,KCRC,KMAX,DA,DC,PI,R,RAD,RE,RYOL(2),ROL(2),	00000060
3 SIG,SIGLM,SIGY,SIGYS(10),SMIN(422),SMAX(422),TH,	00000070
4 UNIT(422),W,DCTMP,DELTMP,DXTMP,	00000080
5 ALOWN,BLOCK,FLAG1,I,ICD(2),ICK(2),ICR(2),IBLOCK,IFIRST,IPRN(4),	00000090
6 ISTEP,ITRANS,J,KTYPE(2),NC,NEQ(10),NR,NRET(10),TYPE,TITL	00000100
INTEGER ALOWN,BLOCK,FLAG1,TYPE(422),CNSTEP,TITL(20)	00000110
REAL KCL,KC1,KOL,KOA(10),KOC(10),KCRA(10),KCRC(10),KMAX,INC	00000120
REAL KA,KC,KAPRE,KCPRE	00000130
K=0	00000140
IFIRST=1	00000150
IF (ITRANS-1) 10,180,10	00000160
10 CONTINUE	00000170
ITRANS=1	00000180
KORIG=KTYPE(1)	00000190
KTYPE(1)=3	00000200
FLAG2=0	00000210
CALL KANAL	00000220
IF (FC*SMAX(I)-KCRC(J)) 110,110,100	00000230
100 WRITE(6,6021) BLOCK,1,CUME	00000240
CUMSUM=CUMSUM+CUMF	00000250
IFAIL=3	00000260
ICR(1)=-1	00000270
RETURN	00000280
110 IF (FLAG1) 140,120,140	00000290
120 IF (FC*SIGLM-KCRC(J)) 140,140,130	00000300
130 FLAG1=1	00000310
ALIM=A	00000320
CLIM=C	00000330
IBLOCK=BLOCK	00000340
ISTEP=1	00000350
CUMELM=CUME	00000360
140 CB=.01	00000370
KTYPE(1)=KORIG	00000380
SIGY=SIGYS(J)	00000390
SIG=SMAX(I)	00000400
R=SMIN(I)/SIG	00000410
150 CALL KANAL	00000420
IF (FA*SIG-KCRC(J)) 180,180,160	00000430
160 CB=CB+.02*C	00000440
FLAG2=1	00000450
IF (CB-C) 150,170,170	00000460
170 WRITE(6,6022) BLOCK,I,CUME	00000470
WRITE(6,6023) CB,C	00000480
IFAIL=4	00000490
ICR(1)=-1	00000500
CUMSUM=CUMSUM+CUMF	00000510
RETURN	00000520
180 DEL=INC*CB	00000530
IF (NRET(J)) 209,209,201	00000540
201 IF (ABS(RYOL(1))- .0001) 209,209,202	00000550
202 IF (DEL-.1*RYOL(1)) 209,209,203	00000560
203 DEL=.1*RYOL(1)	00000570
204 CB=CB+DEL	00000580
IF (CB-.95*C) 220,220,210	00000590
210 ITRANS=0	00000600

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IF (KTYPE(1).NE.2) GO TO 215	00000610
KTYPE(1)=3	00000620
CALL TCGROW	00000630
RETURN	00000640
215 WRITE(6,6110)	00000650
ICR(1)=-1	00000660
CUMSUM=CUMSUM+CUME	00000670
RETURN	00000680
220 CONTINUE	00000690
SIG=SIGLM	00000700
CALL KANAL	00000710
IF (SIGLM*FA-KCRC(J)) 1110,1110,1120	00000720
1110 IF (SIGLM*FC-KCRC(J)) 1130,1130,1120	00000730
1120 FLAG1=1	00000740
CBLIM=CB	00000750
CLIM=C	00000760
IBLOCK=BLOCK	00000770
ISTEP=I	00000780
CUMELM=CUME	00000790
1130 CB=CB-DEL/2	00000800
SIG=SMAX(I)	00000810
R=SMIN(I)/SMAX(I)	00000820
CALL KANAL	00000830
CB=CB-DEL/2	00000840
KA=FA*SIG	00000850
KC=FC*SIG	00000860
DKA=(1-R)*KA	00000870
DKC=(1-R)*KC	00000880
IF (KA-KCRC(J)) 1140,1140,1150	00000890
1140 IF (KC-KCRC(J)) 1160,1160,1153	00000900
1150 IF (FLAG1) 1152,1152,1151	00000910
1151 WRITE(6,6019) IBLOCK,ISTEP,CUMELM	00000920
1152 WRITE (6,6002) BLOCK,I,CUME	00000930
CUMSUM=CUMSUM+CUME	00000940
IFAIL=1	00000950
ICR(1)=-1	00000960
RETURN	00000970
1153 IF (FLAG1) 1155,1155,1154	00000980
1154 WRITE(6,6019) IBLOCK,ISTEP,CUMELM	00000990
1155 WRITE (6,6003) BLOCK,I,CUME	00001000
CUMSUM=CUMSUM+CUME	00001010
IFAIL=2	00001020
ICR(1)=-1	00001030
RETURN	00001040
1160 IF (KOC(J)-DKA) 1180,1170,1170	00001050
1170 DADX=0	00001060
IF (KOC(J)-DKC) 1190,1172,1172	00001070
1172 K=1	00001080
GO TO 1209	00001090
1180 KMAX=KA	00001100
DK=DKA	00001110
NC=1	00001120
CALL DAMAGE	00001130
IF (DXDX) 1192,1184,1184	00001140
1184 DADX=DXDX	00001150
IF (KOC(J)-DKC) 1190,1200,1200	00001160
1190 KMAX=KC	00001170
DK=DKC	00001180
NC=1	00001190
CALL DAMAGE	00001200



IF (DXDX) 1192,1194,1194	00001210
1192 ICR(1)=-1	00001220
WRITE(6,5100)	00001230
CUMSUM=CUMSUM+CUME	00001240
RETURN	00001250
1194 DCDX=DXDX	00001260
GO TO 1210	00001270
1200 DCDX=0	00001280
1210 AVAIL=UNIT(I)-CUME	00001290
1209 IF (IPRN(3)-IPRN(4)) 1211,1215,1215	00001300
1211 IF (IPRN(3)) 1212,1213,1213	00001310
1212 WRITE(6,8002) NR,ITL	00001320
WRITE(6,8003)	00001330
IPRN(3)=0	00001340
DELTMP=0.	00001350
DCTMP=0.	00001360
DXTMP=0.	00001370
1213 IF (IFIRST-1) 1215,1214,1215	00001380
1214 IFIRST=0	00001390
IPRN(3)=IPRN(3)+1	00001400
WRITE(6,8004) BLOCK,1,CUME,C,CB,KC,KA,DCDX,DADX	00001410
IF (K) 5000,1215,5000	00001420
1215 CONTINUE	00001430
IF (ALOWN-1) 1230,1220,1230	00001440
1220 DX=1	00001450
DEL=DADX	00001460
DC=DCDX	00001470
GO TO 1260	00001480
1230 IF (DADX) 1235,1255,1235	00001490
1235 IF (DEL/DADX-AVAIL) 1250,1250,1240	00001500
1240 DELTMP=DELTMP+AVAIL*DADX	00001510
IF (CB) 1241,1242,1241	00001520
1241 IF (DELTMP/CB-1.E-4) 1244,1244,1242	00001530
1242 CB=CB+DELTMP	00001540
DELTMP=0.	00001550
1244 DCTMP=DCTMP+AVAIL*DCDX	00001560
IF (C) 1245,1246,1245	00001570
1245 IF (DCTMP/C-1.E-4) 5000,5000,1246	00001580
1246 C=C+DCTMP	00001590
DCTMP=0.	00001600
GO TO 5000	00001610
1250 DX=DEL/DADX	00001620
DC=DX*DCDX	00001630
GO TO 1260	00001640
1255 DC=INC*C	00001650
IF (RYDL(I)-1.E-4) 1258,1258,1256	00001660
1256 IF (NRFT(J)) 1257,1258,1257	00001670
1257 DC=AMIN(.1*RYDL(I),DC)	00001680
1258 IF (DCDX) 5000,5000,1259	00001690
1259 DX=DC/DCDX	00001700
DEL=DX*DADX	00001710
1260 IF (DX-AVAIL) 1280,1280,1270	00001720
1270 DELTMP=DELTMP+AVAIL*DADX	00001730
IF (CB) 1271,1272,1271	00001740
1271 IF (DELTMP/CB-1.E-4) 1274,1274,1272	00001750
1272 CB=CB+DELTMP	00001760
DELTMP=0.	00001770
1274 DCTMP=DCTMP+AVAIL*DCDX	00001780
IF (C) 1275,1276,1275	00001790
1275 IF (DCTMP/C-1.E-4) 5000,5000,1276	00001800

1276 C=C+DCTMP	00001810
DCTMP=0.	00001820
GO TO 5000	00001830
1280 DELTMP=DELTMP+DEL	00001840
IF (CB) 1281,1282,1281	00001850
1281 IF (DELTMP/CB-1.E-4) 1284,1284,1282	00001860
1282 CB=CB+DELTMP	00001870
DELTMP=0.	00001880
1284 DCTMP=DCTMP+DC	00001890
IF (C) 1285,1286,1285	00001900
1285 IF (DCTMP/C-1.E-4) 1288,1288,1286	00001910
1286 C=C+DCTMP	00001920
DCTMP=0.	00001930
1288 DXTMP=DXTMP+DX	00001940
IF (IPL0T.NE.2) GO TO 1300	00001950
CUMTMP=CUMSUM+CUME	00001960
IF (CUMTMP.LT.PCYC(2)) GO TO 1300	00001970
WRITE(7,7000) A,C,CUMTMP	00001980
PCYC(2)=PCYC(2)+PCYC(1)	00001990
1300 IF (CUME) 1289,1290,1289	00002000
1289 IF (DXTMP/CUME-1.E-4) 180,180,1290	00002010
1290 CUME=CUME+DXTMP	00002020
DXTMP=0.	00002030
GO TO 180	00002040
5000 CONTINUE	00002050
CUME=UNIT(I)	00002060
CUMSUM=CUMSUM+CUME	00002070
IF (IPL0T.NE.2) GO TO 5005	00002080
IF (CUMSUM.LT.PCYC(2)) GO TO 5005	00002090
WRITE(7,7000) A,C,CUMSUM	00002100
PCYC(2)=PCYC(2)+PCYC(1)	00002110
5005 IF (IPRN(3)-IPRN(4)) 5010,5020,5020	00002120
5010 IPRN(3)=IPRN(3)+1	00002130
WRITE(6,8005) BLOCK,I,CUME,C,CB,KC,KA,DCDX,DADX	00002140
IF (IPL0T.NE.1) GO TO 5020	00002150
WRITE(7,7000) A,C,CUMSUM	00002160
5020 CONTINUE	00002170
RETURN	00002180
6002 FORMAT(45HOCRITICAL K AT DEPTH HAS BEEN EXCEEDED IN THE,I6,	00002190
1 14H BLOCK AND THE,I4,11H STEP AFTER,1PE12.3,7H CYCLES )	00002200
6003 FORMAT(47HOCRITICAL K AT SURFACE HAS BEEN EXCEEDED IN THE,I6,	00002210
1 14H BLOCK AND THE,I4,11H STEP AFTER,1PE12.3,7H CYCLES )	00002220
6019 FORMAT(35HOLIMIT LOAD FRACTURE OCCURS IN THE ,I6,7H BLOCK ,	00002230
1 14,12H STEP AFTER ,1PE12.3,7H CYCLES)	00002240
6021 FORMAT(43HOFRACTURE OCCURS DURING BREAKTHROUGH IN THE,	00002250
1 I6,14H BLOCK AND THE,I4,11H STEP AFTER,1PE12.3,7H CYCLES)	00002260
6022 FORMAT(41HOFRACTURE OCCURS DURING TRANSITION IN THE,	00002270
1 I6,14H BLOCK AND THE,I4,11H STEP AFTER,1PE12.3,7H CYCLES)	00002280
6023 FORMAT(4HOCB = ,1PE12.3,7H C = ,E12.3)	00002290
6100 FORMAT(11H,29HCRACK GROWTH RATE IS NEGATIVE,/1H ,	00002300
1 46HACCEPTABLE END OF LIFE IF FROMUN EQUATION USED)	00002310
6110 FORMAT(11H,50HCRACK BECOMING THRU-CRACK. NEED TABLES FOR ANALYSI,	00002320
1 2HS.)	00002330
7000 FORMAT(4HDATA,1P3E12.3)	00002340
8002 FORMAT(5HIRUN ,I4,5X,20A4,/1H0,50X,	00002350
130HCRACK IS A CRACK IN TRANSITION,/1H0,43X,	00002360
225HHALF FRONT HALF BACK,38X,5HFRONT,9X,4HBACK)	00002370
8003 FORMAT(1H ,12X,45HBLOCK STEP CYCLES CRACK LENGTH ,	00002380
160HCRACK LENGTH KMAX-FRONT KMAX-BACK GROWTH RATE ,	00002390
211HGROWTH RATE,/1H ,46X,4H(IN),11X,4H(IN),6X,13H(KSI ROOT-IN),	00002400



32X,13H(KSI PCOT-IN),4X,10H(IN/CYCLE),5X,10H(IN/CYCLE),//)  
8004 FORMAT(10H ,I6,3X,I4,7(3X,1PE12.3))  
8005 FORMAT(10H ,I6,3X,I4,7(3X,1PE12.3))  
END

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SUBROUTINE TCGROW	00000010
COMMON X(12,25),Y(12,25),TABLE(12,25,25),FIXED,KCPRF,KAPRF,	00000020
1 PROOFX,NKTMX,NOX(12),NOY(12),NTAB(10),IPLOT,IFAIL,CUMSUM,PCYC(2)	00000030
COMMON A,AP(2),ALIM,AOL(2),C,CB,CLIM,CR(2,10,10),CO,CUME,	00000040
1 CUMELM,C1B1,D(2,10,10),DK,DKE,DXDX,FA,FC,H,INC,KCL,KC1,KOL,	00000050
2 KOA,KOC,KCRA,KCRC,KMAX,OA,OC,PI,R,RAD,RE,RYOL(2),RUL(2),	00000060
3 SIG,SIGLM,SIGY,SIGYS(10),SMIN(422),SMAX(422),TH,	00000070
4 UNIT(422),W,DCTMP,DELTMP,DXTMP,	00000080
5 ALOWN,BLOCK,FLAG1,I,ICD(2),ICK(2),ICR(2),IBLOCK,IFIRST,IPRN(4),	00000090
6 ISTEP,ITRANS,J,KTYPE(2),NC,NEQ(10),NR,NRET(10),TYPE,TITL	00000100
INTEGER ALOWN,BLOCK,FLAG1,TYPE(422),TITL(20)	00000110
REAL KCL,KC1,KOL,KOA(10),KOC(10),KCRA(10),KCRC(10),KMAX	00000120
REAL INC,KC,KAPRF,KCPRF	00000130
IFIRST=1	00000140
1000 J=TYPE(1)	00000150
1025 DEL=INC*C	00000160
IF (NRET(J)) 1050,1050,1030	00000170
1030 IF (ABS(RYOL(1))-0.0001) 1050,1050,1038	00000180
1038 IF (DEL-.1*RYOL(1)) 1050,1050,1040	00000190
1040 DEL=.1*RYOL(1)	00000200
1050 C=C+DEL	00000210
SIGY=SIGYS(J)	00000220
IF (FLAG1) 1130,1100,1130	00000230
1100 R=0	00000240
SIG=SIGLM	00000250
CALL KANAL	00000260
IF (SIGLM*FC-KCRC(J)) 1130,1130,1120	00000270
1120 FLAG1=1	00000280
CLIM=C	00000290
IBLOCK=BLOCK	00000300
ISTEP=1	00000310
CUMELM=CUME	00000320
1130 C=C-DEL/2	00000330
SIG=SMAX(1)	00000340
R=SMIN(1)/SMAX(1)	00000350
CALL KANAL	00000360
C=C-DEL/2	00000370
KC=FC*SIG	00000380
DKC=(1-R)*KC	00000390
IF (KC-KCRC(J)) 1160,1160,1153	00000400
1153 IF (FLAG1) 1155,1155,1154	00000410
1154 WRITE(6,6019) IBLOCK,ISTEP,CUMELM	00000420
1155 WRITE (6,6003) BLOCK,I,CUME	00000430
IFAIL=2	00000440
CUMSUM=CUMSUM+CUME	00000450
ICR(1)=-1	00000460
RETURN	00000470
1160 IF (KOC(J)-DKC) 1190,1170,1170	00000480
1170 DCDX=0	00000490
GO TO 1180	00000500
1190 KMAX=KC	00000510
DK=DKC	00000520
NC=1	00000530
CALL DAMAGE	00000540
DCDX=DXDX	00000550
1180 IF (IPRN(2)-IPRN(4)) 1191,1195,1195	00000560
1191 IF (IPRN(2)) 1192,1193,1193	00000570
1192 WRITE(6,8002) NR,TITL	00000580
WRITE(6,8003)	00000590
IPRN(2)=0	00000600



DEL TMP=0.	00000610
DXTMP=0.	00000620
1193 IF (IFIRST-1) 1195,1194,1195	00000630
1194 IFIRST=0	00000640
IPRN(2)=IPRN(2)+1	00000650
WRITE(6,8004) BLOCK,I,CUME,C,KC,DCDX	00000660
1195 CONTINUE	00000670
IF (DCDX) 1200,5000,1210	00000680
1200 ICR(1)=-1	00000690
WRITE(6,6100)	00000700
CUMSUM=CUMSUM+CUME	00000710
RETURN	00000720
1210 AVAIL=UNIT(I)-CUME	00000730
IF (ALOWN-1) 1230,1220,1230	00000740
1220 DX=1	00000750
DEL=DCDX	00000760
GO TO 1280	00000770
1230 DX=DEL/DCDX	00000780
IF (DX-AVAIL) 1280,1280,1270	00000790
1270 DELTMP=DELTMP+AVAIL*DCDX	00000800
IF (C) 1271,1272,1271	00000810
1271 IF (DELTMP/C-1.E-4) 5000,5000,1272	00000820
1272 C=C+DELTMP	00000830
DELTMP=0.	00000840
GO TO 5000	00000850
1280 DELTMP=DELTMP+DEL	00000860
IF (C) 1281,1282,1281	00000870
1281 IF (DELTMP/C-1.E-4) 1284,1284,1282	00000880
1282 C=C+DELTMP	00000890
DELTMP=0.	00000900
1284 DXTMP=DXTMP+DX	00000910
IF (IPL0T.NE.2) GO TO 1300	00000920
CUMTMP=CUMSUM+CUME	00000930
IF (CUMTMP.LT.PCYC(2)) GO TO 1300	00000940
WRITE(7,7000) A,C,CUMTMP	00000950
PCYC(2)=PCYC(2)+PCYC(1)	00000960
1300 IF (CUME) 1285,1286,1285	00000970
1285 IF (DXTMP/CUME-1.E-4) 1025,1025,1286	00000980
1286 CUME=CUME+DXTMP	00000990
DXTMP=0.	00001000
GO TO 1025	00001010
5000 CONTINUE	00001020
CUMSUM=CUMSUM+UNIT(I)	00001030
CUME=UNIT(I)	00001040
IF (IPL0T.NE.2) GO TO 5005	00001050
IF (CUMSUM.LT.PCYC(2)) GO TO 5005	00001060
WRITE(7,7000) A,C,CUMSUM	00001070
PCYC(2)=PCYC(2)+PCYC(1)	00001080
5005 IF (IPRN(2)-IPRN(4)) 5010,5020,5020	00001090
5010 IPRN(2)=IPRN(2)+1	00001100
WRITE(6,8005) BLOCK,I,CUME,C,KC,DCDX	00001110
IF (IPL0T.NE.1) GO TO 5020	00001120
WRITE(7,7000) A,C,CUMSUM	00001130
5020 CONTINUE	00001140
RETURN	00001150
6003 FORMAT(47HOCRITICAL K AT SURFACE HAS BEEN EXCEEDED IN THE,16,	00001160
1 14H BLOCK AND THE,14.11H STEP AFTER,1PE12.3.7H CYCLES )	00001170
6019 FORMAT(35HOLIMIT LOAD FRACTURE OCCURS IN THE ,16,7H BLOCK ,	00001180
1 14,12H STEP AFTER ,1PE12.3.7H CYCLES)	00001190
6100 FORMAT(1HC,29HCRACK GROWTH RATE IS NEGATIVE,/1H ,	00001200

1 46HACCEPTABLE END OF LIFE IF FORMAN EQUATION USED)	00001210
7000 FORMAT(4HDATA,1P3F12.3)	00001220
8002 FORMAT(5HIRUN ,I4,5X,20A4,/1H0,50X,24HCRACK IS A THROUGH CRACK,	00001230
1/1H0,46X,4RHALF,25X,5HCRACK)	00001240
8003 FORMAT(1H ,12X,45HBLOCK STEP CYCLES CRACK LENGTH ,	00001250
14X,4PKMAX,7X,11HGROWTH RATE,/1H ,+6X,4H(IN),6X,13H(KSI ROOT-IN),	00001260
24X,10H(IN/CYCLE),//)	00001270
8004 FORMAT(10H ,I6,3X,I4,7(3X,1PE12.3))	00001280
8005 FORMAT(10H ,I6,3X,I4,7(3X,1PE12.3))	00001290
END	00001300



	SUBROUTINE DAMAGE	00000010
	COMMON X(12,25),Y(12,25),TABLE(12,25,25),FIXED,KCPRF,KAPRF,	00000020
	1 PROCFX,NKTMX,NOX(12),NOY(12),NTAB(10),IPLOT,IFAIL,CUMSUM,PCYC(2)	00000030
	COMMON A,AP(2),ALIM,AOL(2),C,CB,CLIM,CR(2,10,10),CO,CUME,	00000040
	1 CUMELM,CIB1,D(2,10,10),DK,DKE,DXDX,FA,FC,H,INC,KCL,KC1,KCL,	00000050
	2 KOA,KOC,KCRA,KCRC,KMAX,GA,GC,PI,R,RAD,RE,RVCL(2),ROL(2),	00000060
	3 SIG,SIGLM,SIGY,SIGYS(10),SMIN(422),SMAX(422),TH,	00000070
	4 UNIT(422),W,DCTMP,DELTMP,DXTMP,	00000080
	5 ALOWN,BLOCK,FLAG1,I,ICD(2),ICK(2),ICR(2),IBLOCK,IFIRST,IPRM(4),	00000090
	6 ISTEP,ITRANS,J,KTYPE(2),NC,NEQ(10),NR,NRET(10),TYPE,TITL	00000100
	INTEGER ALOWN,BLOCK,FLAG1,TYPE(422),TITL(20)	00000110
	REAL KCL,KC1,KOL,KCA(10),KOC(10),KCRA(10),KCRC(10),KMAX,INC	00000120
	REAL KO,KCR,KCPRF,KAPRF	00000130
	RE=R	00000140
	DKE=(1.-RE)*KMAX	00000150
	IF (NEQ(J)) 700,700,10	00000160
10	IF (NEQ(J)-4) 20,20,700	00000170
20	J1=NEQ(J)	00000180
	GO TO (30,200,300,400), J1	00000190
C		00000200
C	COLLIPRIEST-EHRET EQUATION	00000210
C		00000220
	30 CD=D(NC,1,J)	00000230
	PN=D(NC,2,J)	00000240
	KO=D(NC,4,J)	00000250
	KCR=D(NC,3,J)	00000260
	IF (NRET(J)) 80,90,80	00000270
80	CALL RETARD	00000280
90	CC1=ALOG(KCR/KO)	00000290
	CC2=CC1*PN/2.	00000300
	CC1=PN/2.	00000310
	CC1=(KCR*KO)**CC1	00000320
	CC1=CD*CC1	00000330
	T1=(1.-RE)*KCR*KO	00000340
	T1=(DKE**2)/T1	00000350
	T1=ALOG(T1)	00000360
	T2=(1.-R)*KCR/KO	00000370
	T2=ALOG(T2)	00000380
	T1=T1/T2	00000390
	T3=(1.+T1)/(1.-T1)	00000400
	T2=.5*ALOG(T3)	00000410
	T1=CC2*T2	00000420
	T2=EXP(T1)	00000430
	DXDX=CC1*T2	00000440
	GO TO 600	00000450
		00000460
		00000470
		00000480
		00000490
		00000500
		00000510
		00000520
		00000530
		00000540
		00000550
		00000560
		00000570
		00000580
		00000590
		00000600
C		
C	PARIS EQUATION	
C		
	200 IF (NC-2) 220,210,220	
	210 CD=D(2,1,J)	
	PN=D(2,2,J)	
	GO TO 250	
	220 CD=D(1,1,J)	
	PN=D(1,2,J)	
	250 IF (NRET(J)) 260,270,260	
	260 CALL RETARD	
	270 DXDX=-1	
	IF (DKE-KCC(J)) 271,275,275	
	271 IF (NC-1) 275,272,275	
	272 DXDX=0	

TEST = DKE - (1.-RE)\*KCR  
IF (TEST.GT.0.) GO TO 310

P=RE

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GO TO 600	00000610
275 IF (DKE-K0A(J)) 276,278,278	00000620
276 IF (NC-2) 278,277,278	00000630
277 DXDX=0	00000640
GO TO 600	00000650
278 DXDX=CD*DKE**PN	00000660
GO TO 600	00000670
C	00000680
C FORMAN EQUATION	00000690
C	00000700
300 DXDX=-1	00000710
IF (DKE-K0C(J)) 310,330,330	00000720
310 IF (NC-1) 330,320,330	00000730
320 DXDX=0	00000740
GO TO 600	00000750
330 IF (DKE-K0A(J)) 340,360,360	00000760
340 IF (NC-2) 360,350,360	00000770
350 DXDX=0	00000780
GO TO 600	00000790
360 IF ((1.-RE)*D(NC,3,J)-DKE) 370,370,380	00000800
370 WRITE(6,6001)	00000810
GO TO 600	00000820
380 DXDX = D(NC,1,J)*DKE**D(NC,2,J)	00000830
DXDX=DXDX/((1.-RE)*D(NC,3,J)-DKE)	00000840
GO TO 600	00000850
C	00000860
C INTERPOLATION MODEL	00000870
C	00000880
400 NT=NTAB(J)	00000890
IF (NC.EQ.1) GO TO 402	00000900
NT=NT+1	00000910
402 IF (NRET(J)) 420,420,410	00000920
410 CALL RETARD	00000930
420 IF (NT.LT.13) GO TO 430	00000940
WRITE(6,6002)	00000950
STOP	00000960
430 CALL INTP(NT,DKE,RE,2,DXDX)	00000970
RETURN	00000980
600 RETURN	00000990
700 WRITE (6,1000) NEQ(J)	00001000
STOP	00001010
1000 FORMAT (10HNEQ(J) = ,I3,13H OUT OF RANGE)	00001020
6001 FORMAT(39HOCRAK GROWTH RATE HAS GONE TO INFINITY)	00001030
6002 FORMAT(11H, 'NT IS GREATER THAN 12')	00001040
END	00001050



	SUBROUTINE RETARD	00000010
	COMMON XX(12,25),YY(12,25),TABLE(12,25,25),FIXED,KCPRF,KAPRF,	00000020
	1 PROOFX,NKTMX,NOX(12),NOY(12),NTAB(10),IPLDT,IFAIL,CUMSUM,PCYC(2)	00000030
	COMMON A,AP(2),ALIM,AOL(2),C,CR,CLIM,CR(2,10,10),CO,CUME,	00000040
	1 CUMELM,C1BI,D(2,10,10),DK,DKE,DXDX,FA,FC,H,INC,KCL,KC1,KCL,	00000050
	2 KOA,KOC,KCRA,KCRC,KMAX,OA,OC,PI,R,RAD,RE,RYOL(2),ROL(2),	00000060
	3 SIG,SIGLM,SIGY,SIGYS(10),SMIN(422),SMAX(422),TH,	00000070
	4 UNIT(422),W,DCIMP,DELTMP,DXTMP,	00000080
	5 ALLOWN,BLOCK,FLAG1,I,ICD(2),ICK(2),ICR(2),IBLOCK,IFIRST,IPRN(4),	00000090
	6 ISTEP,ITRANS,J,KTYPE(2),NC,NEQ(10),NR,NRET(10),TYPE,TITL	00000100
	INTEGER ALLOWN,BLOCK,FLAG1,TYPE(422),TITL(20)	00000110
	REAL KCL,KC1,KOL,KOA(10),KOC(10),KCRA(10),KCRC(10),KMAX,INC	00000120
	REAL KAP,KMINE,KC2,KMAXE,KCPRF,KAPRF	00000130
	PZ = CR(10,1,J)	00000140
	IF (NRET(J)) 500,500,10	00000150
10	IF (NRET(J)-3) 20,20,500	00000160
20	J1=NRET(J)	00000170
	IF (NC-1) 22,21,22	00000180
21	X=C	00000190
	GO TO 23	00000200
22	X=A	00000210
23	CONTINUE	00000220
	GO TO (30,200,300), J1	00000230
C		00000240
C	WILLENBORG MODEL	00000250
C		00000260
30	RY=(KMAX/SIGY)**2	00000270
	R1=CR(10,1,J)*2.*PI	00000280
	R1=1./R1	00000290
	RY=RY*R1	00000300
	IF (RY-AP(10)+X) 50,40,40	00000310
40	AP(10)=X+RY	00000320
	RYOL(10)=RY	00000330
50	KAP=2*PI*(AP(10)-X)	00000340
	KAP=SQRT(KAP)*SIGY	00000350
	KMAXE=2*KMAX-KAP	00000360
	KMINE=(1+R)*KMAX - KAP	00000370
	IF (KMINE) 60,60,70	00000380
60	KMINE=0	00000390
70	IF (KMAXE) 80,80,90	00000400
80	KMAXE=0	00000410
90	DKE=KMAXE-KMINE	00000420
	RE=KMINE/KMAXE	00000430
	GO TO 430	00000440
C		00000450
C	WHEELER MODEL	00000460
C		00000470
200	RY=(KMAX/SIGY)**2	00000480
	R1=CR(10,1,J)*2.*PI	00000490
	R1=1./R1	00000500
	RY=RY*R1	00000510
	IF (RY-AP(10)+X) 220,210,210	00000520
210	AP(10)=X+RY	00000530
	RYOL(10)=RY	00000540
220	DKE=RY/(AP(10)-X)	00000550
	DKE=DKE**CR(10,2,J)	00000560
	DKE=DKE*(1.-R)*KMAX	00000570
	RE=R	00000580
	GO TO 430	00000590
C		00000600

C	GRUMMAN CLOSURE MODEL	00000610
C		00000620
300	ALOWN=0	00000630
	PZ=CR(NC,1,J)	00000640
	CFM1 = CR(NC,2,J)	00000650
	CF0 = CR(NC,3,J)	00000660
	P = CR(NC,4,J)	00000670
	NSAT = CR(NC,5,J)	00000680
	GAM1 = CR(NC,6,J)	00000690
	BG = CR(NC,7,J)	00000700
	RY=(KMAX/SIGY)**2	00000710
	R1=PZ*2*PI	00000720
	R1=1./R1	00000730
	RY=R1*RY	00000740
	CF2=CFM1+(CF0-CFM1)*(1+R)**P	00000750
	KC2=CF2*KMAX	00000760
	IF (R*KMAX-ROL(NC)*KOL) 310,320,320	00000770
310	ROL(NC)=(R*KMAX)/KOL	00000780
	CF1=CFM1+(CF0-CFM1)*(1+ROL(NC))**P	00000790
	KC1=CF1*KOL	00000800
	ADL(NC)=X	00000810
320	IF (KMAX-KCL) 330,330,340	00000820
330	DKE=0	00000830
	RE=0	00000840
	GO TO 430	00000850
340	IF (KC2-KCL) 350,350,380	00000860
350	IF (AP(NC)-X-KY) 360,370,370	00000870
360	KCL=KC1-(KC1-KC2)*((X-ADL(NC))/RYOL(NC))**BG	00000880
	GO TO 400	00000890
370	KCL=KC2	00000900
	GO TO 400	00000910
380	IF (CUME+1-NSAT) 390,370,370	00000920
390	GAM=GAM1+(1-GAM1)*CUME/(NSAT-1)	00000930
	KCL=GAM*KMAX	00000940
	ALOWN=1	00000950
400	DKE=KMAX-KCL	00000960
	RE=KCL/KMAX	00000970
	IF (AP(NC)-X-RY) 410,420,420	00000980
410	IF (KMAX-KOL) 430,430,420	00000990
420	KC1=KC2	00001000
	KOL=KMAX	00001010
	ROL(NC)=R	00001020
	ADL(NC)=X	00001030
	RYOL(NC)=RY	00001040
	AP(NC)=ADL(NC)+RYOL(NC)	00001050
430	RETURN	00001060
500	WRITE(6,1000) NRET(J)	00001070
1000	FORMAT(11HONRET(J) = ,I3,I3H OUT OF RANGE)	00001080
	STOP	00001090
	END	00001100



SUBROUTINE INTP(NT,XT,YT,INTPEQ,F)	00000010
COMMON X(12,25),Y(12,25),TABLE(12,25,25),FIXED,KCPRF,KAPRF,	00000020
1 PRODFX,NKTMX,NOX(12),NOY(12),NTAB(10),IPLOT,IFAIL,CUMSUM,PCYC(2)	00000030
FEAL KCPRF,KAPRF	00000040
NEND=0	00000050
NUMX=NOX(NT)	00000060
NUMY=NOY(NT)	00000070
IF (X(NT,1).GT.XT) GO TO 5	00000080
IF (X(NT,NUMX).GE.XT) GO TO 10	00000090
5 WRITE(6,6010) XT,NT	00000100
NEND=1	00000110
10 IF (Y(NT,1).GT.YT) GO TO 15	00000120
IF (Y(NT,NUMY).GE.YT) GO TO 20	00000130
15 WRITE(6,6020) YT,NT	00000140
NEND=1	00000150
20 IF (NEND) 30,40,30	00000160
30 STOP	00000170
40 DO 50 IJ=2,NUMX	00000180
IF (XT.LT.X(NT,IJ)) GO TO 60	00000190
50 CONTINUE	00000200
60 NX=IJ	00000210
DO 70 IJ=2,NUMY	00000220
IF (YT.LT.Y(NT,IJ)) GO TO 80	00000230
70 CONTINUE	00000240
80 NY=IJ	00000250
IF (INTPEQ.EQ.1) GO TO 100	00000260
IF (INTPEQ.EQ.2) GO TO 200	00000270
WRITE(6,6030)	00000280
STOP	00000290
C	00000300
C FOUR POINT LINEAR BIVARIATE INTERPOLATION	00000310
C	00000320
100 NXM1=NX-1	00000330
NYM1=NY-1	00000340
P=X(NT,NX)-X(NT,NXM1)	00000350
P=(XT-X(NT,NXM1))/P	00000360
Q=Y(NT,NY)-Y(NT,NYM1)	00000370
Q=(YT-Y(NT,NYM1))/Q	00000380
F00=TABLE(NT,NXM1,NYM1)	00000390
F10=TABLE(NT,NX,NYM1)	00000400
F01=TABLE(NT,NXM1,NY)	00000410
F11=TABLE(NT,NX,NY)	00000420
F=(1.-P)*(1.-Q)*F00 + P*(1.-Q)*F10	00000430
F=F + Q*(1.-P)*F01 + P*Q*F11	00000440
RETURN	00000450
C	00000460
C FOUR POINT LOG-LINEAR BIVARIATE INTERPOLATION	00000470
C	00000480
200 NXM1=NX-1	00000490
NYM1=NY-1	00000500
P=ALOG(XT/X(NT,NXM1))	00000510
P=P/ALOG(X(NT,NX)/X(NT,NXM1))	00000520
Q=Y(NT,NY)-Y(NT,NYM1)	00000530
Q=(YT-Y(NT,NYM1))/Q	00000540
F00=ALOG(TABLE(NT,NXM1,NYM1))	00000550
F10=ALOG(TABLE(NT,NX,NYM1))	00000560
F01=ALOG(TABLE(NT,NXM1,NY))	00000570
F11=ALOG(TABLE(NT,NX,NY))	00000580
F=(1.-P)*(1.-Q)*F00 + P*(1.-Q)*F10	00000590
F=F + Q*(1.-P)*F01 + P*Q*F11	00000600

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F=EXP(F)	00000610
RETURN	00000620
6010 FORMAT(1H0, 4HX = ,1PE12.3,26H IS OUT OF RANGE OF TABLE ,I4)	00000630
6020 FORMAT(1H0, 4HY = ,1PE12.3,26H IS OUT OF RANGE OF TABLE ,I4)	00000640
6030 FORMAT(1H0,21HERROR IN CALL TO INTP)	00000650
END	00000660



SUBROUTINE KANAL	00000010
COMMON X(12,25),Y(12,25),TABLE(12,25,25),FIXED,KCPRF,KAPRF,	00000020
1 PROCFX,NKTMX,NMX(12),NOY(12),NTAB(10),IPLOT,IFAIL,CUMSUM,PCYC(2)	00000030
COMMON A,AP(2),ALIM,AOL(2),C,CB,CLIM,CR(2,10,10),CO,CUME,	00000040
1 CUMFLM,CIB1,D(2,10,10),DK,DKE,DXDX,FA,FC,H,INC,KCL,KC1,KOL,	00000050
2 KOA,KOC,KCRA,KCRC,KMAX,GA,GC,PI,R,RAD,RE,RYCL(2),RUL(2),	00000060
3 SIG,SIGLM,SICY,SIGYS(10),SMIN(422),SMAX(422),TH,	00000070
4 UNIT(422),W,DCIMP,DELTMP,DXTMP,	00000080
5 ALOWN,BLOCK,FLAG1,I,ICD(2),ICK(2),ICK(2),IBLOCK,IFIRST,IPRN(4),	00000090
6 ISTEP,ITRANS,J,KTYPE(2),NC,NFC(10),NR,NRET(10),TYPE,TITL	00000100
INTEGER ALOWN,BLOCK,FLAG1,TYPE(422),TITL(20)	00000110
REAL KCL,KC1,KOL,KOA(10),KOC(10),KCRA(10),KCRC(10),KMAX,INC	00000120
REAL KCPRF,KAPRF	00000130
C	00000140
KT=KTYPE(1)	00000150
GO TO (1000,2000,3000), KT	00000160
C	00000170
C PART THROUGH CRACK	00000180
C	00000190
1000 KT=KTYPE(2)	00000200
GO TO (1020,1040,1060,1080,1100,1120,1140,1160,1180,1200,1220,	00000210
1 1240,1260,1280,1300,1320,1340), KT	00000220
C	00000230
C PTC 01 - CENTER CRACK	00000240
C	00000250
1020 IF (C) 1024,1022,1024	00000260
1022 C=1.E-20	00000270
1024 B=AMINI(A,C)	00000280
B=SQRT(PI*B)	00000290
ADVC=A/C	00000300
FSUR=FUNP1(ADVC,2)	00000310
FDEP=FUNP1(ADVC,1)	00000320
FC=B*FSUR/SQRT(COS(PI*C/W))	00000330
W1=A/TH	00000340
W2=.009*W1-.2315*W1**2-.3673*W1**3+5.28*W1**4	00000350
W2=W2-9.11*W1**5+5.233*W1**6	00000360
W1=A/(2.*C)	00000370
FA=1.109-9.142*W1+41.56*W1**2-86.55*W1**3+65.5*W1**4	00000380
PH12=(W2*FA/.502) + 1.	00000390
PH12=PH12*(1. + .12*(1.-W1)**2)	00000400
FA=B*FDEP*PH12	00000410
GO TO 4000	00000420
C	00000430
C PTC 02 - NO COMPACT CRACK FOR PART-THROUGH	00000440
C	00000450
1040 WRITE(6,6002)	00000460
STOP	00000470
C	00000480
C PTC 03 - SINGLE CORNER CRACK AT HOLE	00000490
C	00000500
1060 CONTINUE	00000510
B=AMINI(A,C)	00000520
FA=SQRT(PI*B)	00000530
FB=1.2133-2.205*(C/(C+RAD))+.6451*(C/(C+RAD))**2	00000540
FB=EXP(FB)	00000550
FS1=1./COS(PI*RAD/W)	00000560
FA=FA*SQRT(FS1)*FB	00000570
ADVC=A/C	00000580
FS1=FUNP1(ADVC,1)	00000590
FS2=FUNP1(ADVC,2)	00000600

FA=FA*FS1	00000610
FC=PI*(C+2.*RAD)/(2.*(W-C))	00000620
FC=SQRT(1./COS(FC))*FB*SQRT(PI*B)*FS2	00000630
GO TO 4000	00000640
C	00000650
C PTC 04 - DOUBLE CORNER CRACK AT HOLE	00000660
C	00000670
1080 CONTINUE	00000680
B=AMIN1(A,C)	00000690
S=C/(C+RAD)	00000700
FB=EXP(1.2133-2.086*S+.8727*S*S)	00000710
FA=SQRT(1./COS(PI*RAD/W))*FB	00000720
ADVC=A/C	00000730
FS1=FUNP1(ADVC,1)	00000740
FS2=FUNP1(ADVC,2)	00000750
FA=FA*FS1*SQRT(PI*B)	00000760
FC=SQRT(PI*B)*SQRT(1./COS(PI*(C+RAD)/W))*FB*FS2	00000770
GO TO 4000	00000780
C	00000790
C PTC 05 - SINGLE INTERNAL CRACK AT HOLE	00000800
C	00000810
1100 CONTINUE	00000820
B=AMIN1(A,C)	00000830
FC=SQRT(PI*B)/1.122	00000840
FS6=C/(C+RAD)	00000850
FB=EXP(1.2133-2.205*FS6+.6451*FS6**2)	00000860
FC=SQRT(1./COS(PI*(C+2.*RAD)/(2.*(W-C))))*FB*FC	00000870
ADVC=A/C	00000880
FS6=FUNP1(ADVC,1)	00000890
FS5=FUNP1(ADVC,2)	00000900
FC=FC*FS6	00000910
FA=SQRT(PI*B)/1.122	00000920
FA=FB*FA*FS5*SQRT(1./COS(PI*RAD/W))	00000930
GO TO 4000	00000940
C	00000950
C PTC 06 - DOUBLE INTERNAL CRACK AT HOLE	00000960
C	00000970
1120 CONTINUE	00000980
B=AMIN1(A,C)	00000990
FC=SQRT(PI*B)/1.122	00010000
FA=FC	00010010
S=C/(RAD+C)	00010020
FB=EXP(1.2133-2.086*S+.8727*S*S)	00010030
FC=SQRT(1./COS(PI*(C+RAD)/W))*FB*FC	00010040
ADVC=A/C	00010050
FS6=FUNP1(ADVC,1)	00010060
FS5=FUNP1(ADVC,2)	00010070
FC=FC*FS6	00010080
FA=FB*FA*FS5*SQRT(1./COS(PI*RAD/W))	00010090
GO TO 4000	00010100
C	00010110
C PTC 07 - INTERPOLATION MODEL - PART-THROUGH CRACK	00010120
C	00010130
1140 FA=SQRT(PI*A)	00010140
FC=FA	00010150
NT=0	00010160
1142 NT=NT+1	00010170
CALL INTP(NT,C,A,1,FCC)	00010180
NT=NT+1	00010190
CALL INTP(NT,C,A,1,FAA)	00010200



FC=FC\*FCC  
 FA=FA\*FAA  
 IF (NT-NKTMX\*2) 1142,4000,4000

PTC 08 - PIN LOADED LUG, SINGLE CORNER CRACK

1160 Z=(C+2.\*RAD)/2.

E=C/2.

F=W/2.

BP=B-E

FS1=2.\*Z/H

FS2=7/BP

PHCP=FUNT1(FS2)

PHCP=PHCP/SQRT(1.-FS2)

PHHP=1.-.08\*FS1+2.69\*FS1\*\*2-.99\*FS1\*\*3

PHWP=1.-.5\*FS2+.957\*FS2\*\*2-.16\*FS2\*\*3

PHWP=PHWP/SQRT(1.-FS2)

PHP=(PHCP+PHHP\*PHWP)/2.

PHP=PHP\*SQRT(1.+(Z+E)/(Z-E)/9.)

PHCS=FUNT2(FS2)

PHCS=PHCS/SQRT(1.-FS2)

PHSS=FUNT3(FS1)

PHSS=PHSS\*SQRT(1./COS(PI\*Z/(2.\*HP)))

S=C/(C+RAD)

FB=EXP(1.2133-2.205\*S+.64\*1\*S\*S)

PHS=(PHCS+PHSS)\*FB/2.

FCP=PHS\*SQRT(PI\*C)/(2.\*W\*TH)

FC=FCP+PHP\*SQRT((Z-E)/(Z+E))/SQRT(PI\*Z)/(2.\*TH)

D1=AMIN1(A,C)

ADVC=A/C

FS2=FUNP1(ADVC,2)

FS4=SQRT(PI\*D1)/SQRT(PI\*C)

FC=FC\*FS2\*FS4

Z=(C+2.\*RAD)/2.

E=C/2.

F=W/2.

BP=B-E

FS1=2.\*Z/H

FS2=7/BP

PHCP=FUNT1(FS2)

PHCP=PHCP/SQRT(1.-FS2)

PHHP=1.08\*FS1+2.69\*FS1\*\*2-.99\*FS1\*\*3

PHWP=1.-.5\*FS2+.957\*FS2\*\*2-.16\*FS2\*\*3

PHWP=PHWP/SQRT(1.-FS2)

PHP=(PHCP+PHHP\*PHWP)/2.

PHCS=FUNT2(FS2)

PHCS=PHCS/SQRT(1.-FS2)

PHSS=FUNT3(FS1)

PHSS=PHSS\*SQRT(1./COS(PI\*Z/(2.\*H)))

S=C/(C+RAD)

FB=EXP(1.2133-2.205\*S+.64\*1\*S\*S)

PHS=(PHCS+PHSS)\*FB/2.

FCP=PHS\*SQRT(PI\*C)/(2.\*W\*TH)

FC=FCP+PHP\*SQRT((Z-E)/(Z+E))/SQRT(PI\*Z)/(2.\*TH)

FC=FC\*SQRT(1.+(Z+E)/(Z-E)/9.)

FA=FUNP1(ADVC,1)

FA=FC\*FA\*FS4

GO TO 4000

PTC 09 - PIN LOADED LUG, TWO CORNER CRACKS

00001210  
 00001220  
 00001230  
 00001240  
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 00001800

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1180	B=W/2.	00001610
	Z=RAD+C	00001820
	PHCP=FUNT1(Z/B)	00001830
	FS1=2.*Z/W	00001840
	FS2=2.*Z/H	00001850
	PHCP=PHCP/SQRT(1.-FS1)	00001860
	PHWP=1.-.5*FS1+.957*FS1**2-.16*FS1**3	00001870
	PHWP=PHWP/SQRT(1.-FS1)	00001880
	PHHP=1.-.08*FS2+2.69*FS2**2-.91*FS2**3	00001890
	PHP=(PHCP+PHWP*PHHP)/2.	00001900
	PHCS=FUNT2(Z/B)	00001910
	PHCS=PHCS/SQRT(1.-FS1)	00001920
	PHSS=FUNT3(FS2)	00001930
	PHSS=PHSS*SQRT(1./COS(PI*Z/W))	00001940
	S=C/(RAD+C)	00001950
	FB=EXP(1.2133-2.086*S+.8727*S*S)	00001960
	PHS=(PHCS+PHSS)*FB/2.	00001970
	FC=1.05*PHP/(2.*TH*SQRT(PI*Z))	00001980
	FC=FC+PHS*SQRT(PI*C)/(2.*W*TH)	00001990
	ADVC=A/C	00002000
	D1=AMIN1(A,C)	00002010
	FS2=FUNP1(ADVC,2)	00002020
	FS4=SQRT(PI*D1)/SQRT(PI*C)	00002030
	FC=FC*FS2*FS4	00002040
		00002050
		00002060
	B=W/2.	00002070
	Z=RAD+C	00002080
	FS1=RAD/B	00002090
	PHCP=FUNT1(FS1)	00002100
	FS2=2.*Z/H	00002110
	PHCP=PHCP/SQRT(1.-FS1)	00002120
	PHWP=1.-.5*FS1+.957*FS1**2-.16*FS1**3	00002130
	PHWP=PHWP/SQRT(1.-FS1)	00002140
	PHHP=1.-.08*FS2+2.69*FS2**2-.91*FS2**3	00002150
	PHP=(PHCP+PHWP*PHHP)/2.	00002160
	PHCS=FUNT2(FS1)	00002170
	PHCS=PHCS/SQRT(1.-FS1)	00002180
	PHSS=FUNT3(FS2)	00002190
	PHSS=PHSS*SQRT(1./COS(PI*RAD/W))	00002200
	S=C/(RAD+C)	00002210
	FB=EXP(1.2133-2.086*S+.8727*S*S)	00002220
	PHS=(PHCS+PHSS)*FB/2.	00002230
	FQ=1.05*PHP/(2.*TH*SQRT(PI*Z))	00002240
	FQ=FQ+PHS*SQRT(PI*C)/(2.*W*TH)	00002250
	FA=FUNP1(ADVC,1)	00002260
	FA=FQ*FA*FS4	00002270
	GO TO 4000	00002280
		00002290
		00002300
	PTC 10 - PIN LOADED LUG, SINGLE INTERNAL CRACK	00002310
1200	Z=(C+2.*RAD)/2.	00002320
	E=C/2.	00002330
	B=W/2.	00002340
	BP=B-E	00002350
	FS1=2.*Z/H	00002360
	FS2=Z/BP	00002370
	PHCP=FUNT1(FS2)	00002380
	PHCP=PHCP/SQRT(1.-FS2)	00002390
	PHHP=1.-.08*FS1+2.69*FS1**2-.99*FS1**3	00002400



```

PHWP=1.-.5*FS2+.957*FS2**2-.16*FS2**3
PHWP=PHWP/SQRT(1.-FS2)
PHP=(PHCP+PHWP*PHWP)/2.
PHP=PHP*SQRT(1.+(Z+E)/(Z-E)/9.)
PHCS=FUNT2(FS2)
PHCS=PHCS/SQRT(1.-FS2)
PHSS=FUNT3(FS1)
PHSS=PHSS*SQRT(1./COS(PI*Z/(2.*H)))
S=C/(C+RAD)
FH=EXP(1.2133-2.205*S+.6451*S*S)
PHS=(PHCS+PHSS)*FH/2.
FCP=PHS*SQRT(PI*C)/(2.*W*TH)
FC=FCP+PHP*SQRT((Z-E)/(Z+E))/SQRT(PI*Z)/(2.*TH)
DI=AMIN1(A,C)
ADVC=A/C
FS4=SQRT(PI*DI)/SQRT(PI*C)
FA=FUNP1(ADVC,1)
FC=FC*FA/1.122*FS4
Z=(C+2.*RAD)/2.
E=C/2.
B=W/2.
BP=B-E
FS1=2.*Z/H
FS2=RAD/B
PHCP=FUNT1(FS2)
PHCP=PHCP/SQRT(1.-FS2)
PHWP=1.-.5*FS1+2.69*FS1**2-.99*FS1**3
PHWP=PHWP/SQRT(1.-FS2)
PHP=(PHCP+PHWP*PHWP)/2.
PHCS=FUNT2(FS2)
PHCS=PHCS/SQRT(1.-FS2)
PHSS=FUNT3(FS1)
PHSS=PHSS*SQRT(1./COS(PI*RAD/(2.*B)))
S=C/(C+FA)
FH=EXP(1.2133-2.205*S+.6451*S*S)
PHS=(PHCS+PHSS)*FH/2.
FCP=PHS*SQRT(PI*C)/(2.*W*TH)
FC=FCP+PHP*SQRT((Z-E)/(Z+E))/SQRT(PI*Z)/(2.*TH)
FC=FC*SQRT(1.+(Z+E)/(Z-E)/9.)
FA=FUNP1(ADVC,2)
FA=FC*FA/1.122*FS4
GO TO 4000

```

PIC 11 - PIN LOADED LUG, TWO INTERNAL CRACKS

```

1220 B=W/2.
Z=RAD+C
PHCP=FUNT1(Z/B)
FS1=2.*Z/W
FS2=2.*Z/H
PHCP=PHCP/SQRT(1.-FS1)
PHWP=1.-.5*FS1+.957*FS1**2-.16*FS1**3
PHWP=PHWP/SQRT(1.-FS1)
PHWP=1.-.08*FS2+2.69*FS2**2-.91*FS2**3
PHP=(PHCP+PHWP*PHWP)/2.
PHCS=FUNT2(Z/B)
PHCS=PHCS/SQRT(1.-FS1)
PHSS=FUNT3(FS2)
PHSS=PHSS*SQRT(1./COS(PI*Z/W))

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S=C/(RAD+C)	00003010
FB=EXP(1.2133-2.086*S+.8727*S*S)	00003020
PHS=(PHCS+PHSS)*FB/2.	00003030
FC=1.05*PHP/(2.*TH*SQR(TPI*Z))	00003040
FC=FC+PHS*SQR(TPI*C)/(2.*W*TH)	00003050
D1=AMIN1(A,C)	00003060
ADVC=A/C	00003070
FS4=SQR(TPI*D1)/SQR(TPI*C)	00003080
FA=FUNP1(ADVC,1)	00003090
FC=FC*FA/1.122*FS4	00003100
C	00003110
B=W/2.	00003120
Z=RAD+C	00003130
FS1=RAD/B	00003140
PHCP=FUNT1(FS1)	00003150
FS2=2.*Z/H	00003160
PHCP=PHCP/SQR(T1.-FS1)	00003170
PHWP=1.-.5*FS1+.957*FS1**2-.16*FS1**3	00003180
PHWP=PHWP/SQR(T1.-FS1)	00003190
PPHP=1.-.08*FS2+2.69*FS2**2-.91*FS2**3	00003200
PHP=(PHCP+PHWP*PPHP)/2.	00003210
PHCS=FUNT2(FS1)	00003220
PHCS=PHCS/SQR(T1.-FS1)	00003230
PHSS=FUNT3(FS2)	00003240
PHSS=PHSS*SQR(T1./COS(PI*RAD/W))	00003250
S=C/(RAD+C)	00003260
FB=EXP(1.2133-2.086*S+.8727*S*S)	00003270
PHS=(PHCS+PHSS)*FB/2.	00003280
FQ=1.05*PHP/(2.*TH*SQR(TPI*Z))	00003290
FQ=FQ+PHS*SQR(TPI*C)/(2.*W*TH)	00003300
FA=FUNP1(ADVC,2)	00003310
FA=FQ*FA/1.122*FS4	00003320
GO TO 4000	00003330
C	00003340
C	00003350
C	00003360
1240 B=H	00003370
FS2=.752+2.02*((B+C)/W)+.37*(1.-SIN(PI*(B+C)/2./W))**3	00003380
FW=FS2/COS(PI*(B+C)/2./W)/1.122	00003390
FW=FW*SQR(TW*2./PI/(B+C)*TAN(PI*(B+C)/W/2.))	00003400
FS1=RAD/B	00003410
IF (FS1.LT. .01) GO TO 1242	00003420
S=C/(B+C)	00003430
FC=FUNT4(S,FS1)	00003440
FC=FC*FW*SQR(TPI*C)	00003450
GO TO 1244	00003460
1242 FC=1.122*SQR(TB+C)*FW	00003470
1244 ADVC=A/C	00003480
D1=AMIN1(A,C)	00003490
FC=FC*SQR(TPI*D1)/SQR(TPI*C)*FUNP1(ADVC,2)	00003500
C	00003510
FS2=.752+2.02*(B/W)+.37*(1.-SIN(PI*B/W/2.))**3	00003520
FW=FS2/COS(PI*B/W/2.)/1.122	00003530
FW=FW*SQR(TW*2./PI/B*TAN(PI*B/W/2.))	00003540
FS1=RAD/B	00003550
IF (FS1.LT. .01) GO TO 1246	00003560
S=C/B	00003570
FQ=FUNT4(S,FS1)	00003580
FQ=FQ*FW*SQR(TPI*C)	00003590
GO TO 1248	00003600



1246	FQ=1.122*SQRT(B)*FW	00003610
1248	FA=FQ*SQRT(PI*D1)/SQRT(PI*C)*FUNP1(ADVC,1)	00003620
	GO TO 4000	00003630
C		00003640
C	PTC 13 - DOUBLE CORNER CRACK AT DOUBLE NOTCH	00003650
C		00003660
1260	B=H	00003670
	FS2=.752+2.02*((B+C)/(W/2.))+.37*(1.-SIN(PI*(B+C)/W))*3	00003680
	FW=FS2/COS(PI*(B+C)/W)/1.122	00003690
	FW=FW*SQRT(W/PI/(B+C)*TAN(PI*(B+C)/W))	00003700
	FS1=RAD/B	00003710
	IF (FS1.LT. .01) GO TO 1262	00003720
	S=C/(B+C)	00003730
	FC=FUNT4(S,FS1)	00003740
	FC=FC*FW*SQRT(PI*C)	00003750
	GO TO 1264	00003760
1262	FC=1.122*SQRT(B+C)*FW	00003770
1264	ADVC=A/C	00003780
	D1=AMIN1(A,C)	00003790
	FW=(1.+1.122*(COS(PI*(B+C)/W))*4)*CLS(PI*(B+C)/W)	00003800
	FC=FC*FW/FS2	00003810
	FC=FC*SQRT(PI*D1)/SQRT(PI*C)*FUNP1(ADVC,2)	00003820
	FS2=.752+2.02*(B/(W/2.))+.37*(1.-SIN(PI*B/W))*3	00003830
	FW=FS2/COS(PI*B/W)/1.122	00003840
	FW=FW*SQRT(W/PI/B*TAN(PI*B/W))	00003850
	FS1=RAD/B	00003860
	IF (FS1.LT. .01) GO TO 1266	00003870
	S=C/B	00003880
	FQ=FUNT4(S,FS1)	00003890
	FQ=FQ*FW*SQRT(PI*C)	00003900
	GO TO 1268	00003910
1266	FQ=1.122*SQRT(B)*FW	00003920
1268	CONTINUE	00003930
	FW=(1.+1.122*(COS(PI*B/W))*4)*CLS(PI*B/W)	00003940
	FC=FQ*FW/FS2	00003950
	FA=FQ*SQRT(PI*D1)/SQRT(PI*C)*FUNP1(ADVC,1)	00003960
	GO TO 4000	00003970
C		00003980
C	PTC 14 - SINGLE INTERNAL CRACK AT SINGLE NOTCH	00003990
C		00004000
1280	B=H	00004010
	FS2=.752+2.02*((B+C)/W)+.37*(1.-SIN(PI*(B+C)/W/2.))*3	00004020
	FW=FS2/COS(PI*(B+C)/W/2.)/1.122	00004030
	FW=FW*SQRT(W*2./PI/(B+C)*TAN(PI*(B+C)/W/2.))	00004040
	FS1=RAD/B	00004050
	IF (FS1.LT. .01) GO TO 1282	00004060
	S=C/(B+C)	00004070
	FC=FUNT4(S,FS1)	00004080
	FC=FC*FW*SQRT(PI*C)	00004090
	GO TO 1284	00004100
1282	FC=1.122*SQRT(B+C)*FW	00004110
1284	ADVC=A/C	00004120
	D1=AMIN1(A,C)	00004130
	FC=FC*SQRT(PI*D1)/SQRT(PI*C)*FUNP1(ADVC,1)/1.122	00004140
C		00004150
	FS2=.752+2.02*(B/W)+.37*(1.-SIN(PI*B/W/2.))*3	00004160
	FW=FS2/COS(PI*B/W/2.)/1.122	00004170
	FW=FW*SQRT(W*2./PI/B*TAN(PI*B/W/2.))	00004180
	FS1=RAD/B	00004190
	IF (FS1.LT. .01) GO TO 1286	00004200

S=C/B	00004210
FQ =FUNT4(S,FS1)	00004220
FQ=FQ*FW*SQRT(PI*C)	00004230
GO TO 1288	00004240
1286 FQ=1.122*SQRT(B)*FW	00004250
1288 FA=FQ*SQRT(PI*D1)/SQRT(PI*C)*FUNP1(AOVC,2)/1.122	00004260
GO TO 4000	00004270
C	00004280
C PTC 15 - DOUBLE INTERNAL CRACK AT DOUBLE NOTCH	00004290
C	00004300
1300 B=H	00004310
FS2=.752+2.02*((B+C)/(W/2.))+.37*(1.-SIN(PI*(B+C)/W))*3	00004320
FW=FS2/COS(PI*(B+C)/W)/1.122	00004330
FW=FW*SQRT(W/PI/(B+C)*TAN(PI*(B+C)/W))	00004340
FS1=RAD/B	00004350
IF (FS1.LT. .01) GO TO 1302	00004360
S=C/(B+C)	00004370
FC =FUNT4(S,FS1)	00004380
FC=FC*FW*SQRT(PI*C)	00004390
GO TO 1304	00004400
1302 FC=1.122*SQRT(B+C)*FW	00004410
1304 AOVC=A/C	00004420
D1=AMIN1(A,C)	00004430
FW=(1.+.122*(COS(PI*(B+C)/W))*4)*COS(PI*(B+C)/W)	00004440
FC=FC*FW/FS2	00004450
FC=FC*SQRT(PI*D1)/SQRT(PI*C)*FUNP1(AOVC,1)/1.122	00004460
FS2=.752+2.02*(B/(W/2.))+.37*(1.-SIN(PI*B/W))*3	00004470
FW=FS2/COS(PI*B/W)/1.122	00004480
FW=FW*SQRT(W/PI/B*TAN(PI*B/W))	00004490
FS1=RAD/B	00004500
IF (FS1.LT. .01) GO TO 1306	00004510
S=C/B	00004520
FQ =FUNT4(S,FS1)	00004530
FQ=FQ*FW*SQRT(PI*C)	00004540
GO TO 1308	00004550
1306 FQ=1.122*SQRT(B)*FW	00004560
1308 CONTINUE	00004570
FW=(1.+.122*(COS(PI*B/W))*4)*COS(PI*B/W)	00004580
FQ=FQ*FW/FS2	00004590
FA=FQ*SQRT(PI*D1)/SQRT(PI*C)*FUNP1(AOVC,2)/1.122	00004600
GO TO 4000	00004610
C	00004620
C PTC 16 - CORNER CRACK OUT OF SHOULDER	00004630
C	00004640
1320 B1=(W-H)/2.	00004650
S1=C/(C+B1)	00004660
FC=W/PI/(C+B1)*TAN(PI*(C+B1)/W)	00004670
FC=SQRT(FC)	00004680
FC=FC*(1.+.122*(COS(PI*(C+B1)/W))*4)/1.122	00004690
FC=FC*SQRT(PI*C)*FUNT4(S1,C1B1)	00004700
AOVC=A/C	00004710
D1=AMIN1(A,C)	00004720
FC=FC*SQRT(PI*D1)/SQRT(PI*C)*FUNP1(AOVC,2)	00004730
B1=(W-H)/2.	00004740
S1=C/B1	00004750
FQ=W/PI/B1*TAN(PI*B1/W)	00004760
FQ=FQ*(1.+.122*(COS(PI*B1/W))*4)	00004770
FQ=FQ*SQRT(PI*C)*FUNT4(S1,C1B1)	00004780
FA=FQ*SQRT(PI*D1)/SQRT(PI*C)*FUNP1(AOVC,1)	00004790
GO TO 4000	00004800



C		00004810
C	PTC 17 - INTERNAL CRACK OUT OF SHOULDER	00004820
C		00004830
1340	B1=(W-H)/2.	00004840
	S1=C/(C+B1)	00004850
	FC=W/PI/(C+B1)*TAN(PI*(C+B1)/W)	00004860
	FC=SQRT(FC)	00004870
	FC=FC*(1.+1.122*(COS(PI*(C+B1)/W))**.5)/1.122	00004880
	FC=FC*SQRT(PI*C)*FUNT4(S1,C1B1)	00004890
	ADVC=A/C	00004900
	D1=AMIN1(A,C)	00004910
	FC=FC*SQRT(PI*D1)/SQRT(PI*C)*FUNP1(ADVC,1)	00004920
	B1=(W-H)/2.	00004930
	S1=C/B1	00004940
	FQ=W/PI/B1*TAN(PI*B1/W)	00004950
	FQ=FQ*(1.+1.122*(COS(PI*B1/W))**.5)	00004960
	FQ=FQ*SQRT(PI*C)*FUNT4(S1,C1B1)	00004970
	FA=FQ*SQRT(PI*D1)/SQRT(PI*C)*FUNP1(ADVC,2)	00004980
	GO TO 4000	00004990
C		00005000
C	TRANSITION CRACK	00005010
C		00005020
2000	CHOLD=C	00005030
	C=(C+CB)/2.	00005040
C		00005050
	KT=KTYPE(2)	00005060
	GO TO (3020,3040,3060,3080,3060,3080,3140,3160,3180,3160,3180,	00005070
	1 3240,3260,3240,3260,3320,3320), KT	00005080
C		00005090
2100	C=CHOLD	00005100
	FA=1.-SQRT(1.-(CB/C)**2)	00005110
	FA=CB/(C*FA)	00005120
	FA=SQRT(FA)*FC	00005130
	GO TO 4000	00005140
C		00005150
C	THROUGH CRACK EQUATIONS	00005160
C		00005170
3000	KT=KTYPE(2)	00005180
	GO TO (3020,3040,3060,3080,3060,3080,3140,3160,3180,3160,3180,	00005190
	1 3240,3260,3240,3260,3320,3320), KT	00005200
C		00005210
C	TC 01 - CENTER CRACKED PANEL	00005220
C		00005230
3020	Z = PI*C	00005240
	Q= SQRT(Z)	00005250
	Z = COS(Z/W)	00005260
	Z = 1./Z	00005270
	Z = SQRT(Z)	00005280
	FC = Q*Z	00005290
	FA = 0	00005300
	IF (KTYPE(1).EQ.2) GO TO 2100	00005310
	GO TO 4000	00005320
C		00005330
C	TC 02 - COMPACT SPECIMEN	00005340
C		00005350
3040	W1 = C/W	00005360
	W2 = SQRT(W1)	00005370
	FC = 29.6*W2 - 185.5*W1*W2	00005380
	W2 = W2*W1*W1	00005390
	FC = FC + 655.7*W2 - 1017.0*W2*W1	00005400

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W2 = W2*W1*W1	00005410
FC = FC + 638.9 * W2	00005420
FC = FC/TH	00005430
FC = FC/SQRT(W)	00005440
FA = 0	00005450
IF (KTYPE(1).EQ.2) GO TO 2100	00005460
GO TO 4000	00005470
C	00005480
C TC 03,05 - SINGLE THROUGH CRACK AT HOLE	00005490
C	00005500
3060 S=C/(RAD+C)	00005510
FB=EXP(1.2133-2.205*S+.6451*S*S)	00005520
FC=COS((C+2.*RAD)*PI/(2.*(W-C)))	00005530
FC=SQRT(1./FC)	00005540
FC=FC*SQRT(PI*C)*FB	00005550
FA=0.	00005560
IF (KTYPE(1).EQ.2) GO TO 2100	00005570
GO TO 4000	00005580
C	00005590
C TC 04,06 - DOUBLE THROUGH CRACK AT HOLE	00005600
C	00005610
3080 S=C/(RAD+C)	00005620
FB=EXP(1.2133-2.086*S+.8727*S*S)	00005630
FC=COS(PI*(C+RAD)/W)	00005640
FC=SQRT(1./FC)*FB*SQRT(PI*C)	00005650
FA=0.	00005660
IF (KTYPE(1).EQ.2) GO TO 2100	00005670
GO TO 4000	00005680
C	00005690
C TC 07 - INTERPOLATION MODEL - THROUGH CRACK	00005700
C	00005710
3140 FC=SQRT(PI*C)	00005720
CALL INTP(1,C,A,1,FCC)	00005730
FC=FC*FCC	00005740
FA=0	00005750
IF (KTYPE(1).EQ.2) GO TO 2100	00005760
GO TO 4000	00005770
C	00005780
C TC 08,10 - PIN LOADED LUG, SINGLE THROUGH CRACK	00005790
C	00005800
3160 Z=(C+2.*RAD)/2.	00005810
E=C/2.	00005820
B=W/2.	00005830
BP=B-F	00005840
FS1=2.*Z/H	00005850
FS2=Z/BP	00005860
PHCP=FUNT1(FS2)	00005870
PHCP=PHCP/SQRT(1.-FS2)	00005880
PHHP=1.-.08*FS1+2.69*FS1**2-.99*FS1**3	00005890
PHWP=1.-.5*FS2+.957*FS2**2-.16*FS2**3	00005900
PHWP=PHWP/SQRT(1.-FS2)	00005910
PHP=(PHCP+PHHP*PHWP)/2.	00005920
PHP=PHP*SQRT(1.+(Z+E)/(Z-E)/9.)	00005930
PHCS=FUNT2(FS2)	00005940
PHCS=PHCS/SQRT(1.-FS2)	00005950
PHSS=FUNT3(FS1)	00005960
PHSS=PHSS*SQRT(1./COS(PI*Z/(2.*BP)))	00005970
S=C/(C+RAD)	00005980
FB=EXP(1.2133-2.205*S+.6451*S*S)	00005990
PHS=(PHCS+PHSS)*FB/2.	00006000



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FCP=PHS*SQRT(PI*C)/(2.*W*TH)
FC=FCP+PHP*SQRT((Z-E)/(Z+E))/SQRT(PI*Z)/(2.*TH)
FA=0.
IF (KTYPE(1).EQ.2) GO TO 2100
GO TO 4000

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TC 09,11 - PIN LOADED LUG, DOUBLE THROUGH CRACKS

```

3180 B=W/2.
Z=RAD+C
PHCP=FUNT1(Z/B)
FS1=2.*Z/W
FS2=2.*Z/H
PHCP=PHCP/SQRT(1.-FS1)
PHWP=1.-.5*FS1+.957*FS1**2-.16*FS1**3
PHWP=PHWP/SQRT(1.-FS1)
PHHP=1.-.08*FS2+2.69*FS2**2-.91*FS2**3
PHP=(PHCP+PHWP*PHHP)/2.
PHCS=FUNT2(Z/B)
PHCS=PHCS/SQRT(1.-FS1)
PHSS=FUNT3(FS2)
PHSS=PHSS*SQRT(1./COS(PI*Z/W))
S=C/(RAD+C)
FR=EXP(1.2133-2.086*S+.8727*S*S)
PHS=(PHCS+PHSS)*FR/2.
FC=1.05*PHP/(2.*TH*SQRT(PI*Z))
FC=FC+PHS*SQRT(PI*C)/(2.*W*TH)
FA=0.
IF (KTYPE(1).EQ.2) GO TO 2100
GO TO 4000

```

TC 12,14 - SINGLE CRACK AT SINGLE NOTCH

```

3240 B=H
FS2=.752+2.02*((B+C)/W)+.37*(1.-SIN(PI*(B+C)/W/2.))**3
FW=FS2/COS(PI*(B+C)/W/2.)/1.122
FW=FW*SQRT(W*2./PI/(B+C)*TAN(PI*(B+C)/W/2.))
FS1=RAD/B
IF (FS1.LT. .01) GO TO 3242
S=C/(B+C)
FC=FUNT4(S,FS1)
FC=FC*FW*SQRT(PI*C)
GO TO 3244
3242 FC=1.122*SQRT(B+C)*FW
3244 FA=0.
IF (KTYPE(1).EQ.2) GO TO 2100
GO TO 4000

```

TC 13,15 - DOUBLE CRACK AT DOUBLE NOTCH

```

3260 B=H
FS2=.752+2.02*((B+C)/(W/2.))+.37*(1.-SIN(PI*(B+C)/W))**3
FW=FS2/COS(PI*(B+C)/W)/1.122
FW=FW*SQRT(W/PI/(B+C)*TAN(PI*(B+C)/W))
FS1=RAD/B
IF (FS1.LT. .01) GO TO 3262
S=C/(B+C)
FC=FUNT4(S,FS1)
FC=FC*FW*SQRT(PI*C)
GO TO 3264

```

3262	FC=1.122*SQRT(B+C)*FW	00006610
3264	FA=0.	00006620
	FW=(1.+1.122*(COS(PI*(B+C)/W))**4)*COS(PI*(B+C)/W)	00006630
	FC=FC*FW/FS2	00006640
	IF (KTYPE(1).EQ.2) GO TO 2100	00006650
	GO TO 4000	00006660
C		00006670
C	TC 16,17 - CRACK OUT OF SHOULDER	00006680
C		00006690
3320	B1=(W-H)/2.	00006700
	S1=C/(C+B1)	00006710
	FC=W/PI/(C+B1)*TAN(PI*(C+B1)/W)	00006720
	FC=SQRT(FC)	00006730
	FC=FC*(1.+1.122*(COS(PI*(C+B1)/W))**4)/1.122	00006740
	FC=FC*SQRT(PI*C)*FUNT4(S1,C1B1)	00006750
	FA=0.	00006760
	IF (KTYPE(1).EQ.2) GO TO 2100	00006770
	GO TO 4000	00006780
C		00006790
4000	RETURN	00006800
6002	FORMAT(1HC,'NO COMPACT CRACK FOR PART-THROUGH')	00006810
	END	00006820



```

FUNCTION FUNP1(X,IX)
  DIMENSION ADVC(25),FUNS(25,2)

```

00006830

00006840

00006850

00006860

00006870

00006880

00006890

00006900

00006910

00006920

00006930

00006940

00006950

00006960

00006970

00006980

00006990

00007000

00007010

00007020

00007030

00007040

00007050

00007060

00007070

00007080

```

DATA ADVC /0.,.04.,.07.,.12.,.15.,.21.,.34.,.58.,.72.,.775.,.86,1.,1.25,
1 1.49,1.785,2.325,3.45,5.,6.66,10.,25.,50.,100.,10000.,10000./
DATA FUNS /1.122,1.11,1.1,1.08,1.07,1.04,.97,.84,.77,.75,.71,
1 .655,.65,.63,.61,.57,.5,.43,.35,.31,.17,.1,.05,0.,0.,
2 0.,.17,.27,.37,.42,.5,.6,.71,.74,.75,.76,.775,.82,.86,
3 .9,.96,.975,.99,.998,1.,1.,1.,1.,1.,1./

```

```

  IF (ADVC(1).GT.X) GO TO 5
  IF (ADVC(25).GE.X) GO TO 10

```

```

5 WRITE (6,6000) X
  STOP

```

```

10 DO 20 I=2,24
  IF (X.LT.ADVC(I)) GO TO 30

```

```

20 CONTINUE
  I=2+

```

```

30 J=I-1
  T=ADVC(I)-ADVC(J)
  T=(X-ADVC(J))/T
  FUNP1=FUNS(J,IX)+T*(FUNS(I,IX)-FUNS(J,IX))
  RETURN

```

```

C 6000 FORMAT(1P0,'FUNP1: X= ',1PF12.2,' IS OUT OF RANGE')
  END

```

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FUNCTION FUNT1(X)	00007090
C	00007100
DIMENSION VALUE(14),FUNS(14)	00007110
C	00007120
DATA VALUE /0.,.06,.12,.19,.34,.4,.48,.54,.6,.72,.8,.86,.96,1./	00007130
DATA FUNS /1.,.98,1.,1.06,1.24,1.3,1.36,1.38,1.395,1.395,1.38,	00007140
1 1.36,1.32,1.297/	00007150
C	00007160
IF (VALUE(1).GT.X) GO TO 5	00007170
IF (VALUE(14).GE.X) GO TO 10	00007180
5 WRITE(6,6000) X	00007190
STOP	00007200
10 DO 20 I=2,14	00007210
IF (X.LE.VALUE(I)) GO TO 30	00007220
20 CONTINUE	00007230
I=14	00007240
30 J=I-1	00007250
T=VALUE(I)-VALUE(J)	00007260
T=(X-VALUE(J))/T	00007270
FUNT1=FUNS(J)+T*(FUNS(I)-FUNS(J))	00007280
RETURN	00007290
C	00007300
6000 FORMAT(1H0,'FUNT1: X = ',1PE12.3,' IS OUT OF RANGE')	00007310
END	00007320

	FUNCTION FUNT2(X)	00007320
C		00007340
	DIMENSION VALUE(16),FUNS(16)	00007350
C		00007360
	DATA VALUE /0.,.06,.13,.18,.2,.26,.32,.62,.7,.76,.8,.86,.9,.94,	00007370
1	.97,1./	00007380
	DATA FUNS /1.,.98,.96,.95,.95,.95,1.,1.01,1.01,1.,.98,	00007390
1	.96,.97,.88,.826/	00007400
C		00007410
	IF (VALUE(1).GT.X) GO TO 5	00007420
	IF (VALUE(16).GE.X) GO TO 10	00007430
	5 WRITE(6,6000) X	00007440
	STOP	00007450
	10 DO 20 I=2,16	00007460
	IF (X.LE.VALUE(I)) GO TO 30	00007470
	20 CONTINUE	00007480
	I=16	00007490
	30 J=I-1	00007500
	T=VALUE(I)-VALUE(J)	00007510
	T=(X-VALUE(J))/T	00007520
	FUNT2=FUNS(J)+T*(FUNS(I)-FUNS(J))	00007530
	RETURN	00007540
C		00007550
	6000 FORMAT(1H0,'FUNT2: X = ',1PE12.3,' IS OUT OF RANGE')	00007560
	END	00007570

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FUNCTION FUNT3(X)	00007580
C	00007590
DIMENSION VALUE(16),FUNS(16)	00007600
C	00007610
DATA VALUE /0.,.1666,.2,.25,.3333,.5,.5714,.6315,.8,.8888,	00007620
1 1.0909,1.2632,1.6,2.1819,2.6666,4.8007/	00007630
DATA FUNS /1.,1.0542,1.0666,1.075,1.0916,1.25,1.3333,1.4166,	00007640
1 1.625,1.75,2.,2.24,2.72,3.64,4.416,8./	00007650
C	00007660
IF (VALUE(I).GT.X) GO TO 5	00007670
IF (VALUE(16).GE.X) GO TO 10	00007680
5 WRITE(6,6000) X	00007690
STOP	00007700
10 DO 20 I=2,16	00007710
IF (X.LE.VALUE(I)) GO TO 30	00007720
20 CONTINUE	00007730
I=16	00007740
30 J=I-1	00007750
T=VALUE(I)-VALUE(J)	00007760
T=(X-VALUE(J))/T	00007770
FUNT3=FUNS(J)+T*(FUNS(I)-FUNS(J))	00007780
RETURN	00007790
C	00007800
6000 FORMAT(1H0,'FUNT3: X = ',1PE12.3,' IS OUT OF RANGE')	00007810
END	00007820



	FUNCTION FUNT4(S,R)	00007830
C		00007840
	DIMENSION SVAL(9),RVAL(8),TABL(8,9)	00007850
C		00007860
	DATA SVAL /0.01,.05,.1,.2,.3,.4,.6,.8,1./	00007870
	DATA RVAL /0.,.25,.333,.5,1.,2.,4.,1.E+61/	00007880
	DATA TABL /11.22,4.5,8.4,5.8,2.5,2.3,1.5,1.122,	00007890
2	5.02,5.02,5.02,4.1,3.,2.2,1.45,1.122,	00007900
3	3.55,3.55,3.55,3.5,2.8,2.2,1.4,1.122,	00007910
4	2.51,2.51,2.51,2.51,2.4,2.,1.35,1.122,	00007920
5	2.05,2.05,2.05,2.05,2.,1.8,1.3,1.122,	00007930
6	1.77,1.77,1.77,1.77,1.77,1.7,1.25,1.122,	00007940
7	1.45,1.45,1.45,1.45,1.45,1.35,1.2,1.122,	00007950
8	1.25,1.25,1.25,1.25,1.25,1.25,1.18,1.122,	00007960
9	1.122,1.122,1.122,1.122,1.122,1.122,1.122,1.122/	00007970
C		00007980
	IF (S.LT.SVAL(1)) GO TO 1000	00007990
	IF (S.GT.SVAL(9)) GO TO 1000	00008000
	IF (R.LT.RVAL(1)) GO TO 2000	00008010
	IF (R.GT.RVAL(8)) GO TO 2000	00008020
C		00008030
	DO 10 IS=2,9	00008040
	IF (S.LT.SVAL(IS)) GO TO 20	00008050
10	CONTINUE	00008060
	IS=9	00008070
20	DO 30 IR=2,8	00008080
	IF (R.LT.RVAL(IR)) GO TO 40	00008090
30	CONTINUE	00008100
	IR=8	00008110
40	ISM1=IS-1	00008120
	IRM1=IR-1	00008130
	PS=SVAL(IS)-SVAL(ISM1)	00008140
	PS=(S-SVAL(ISM1))/PS	00008150
	PR=RVAL(IR)-RVAL(IRM1)	00008160
	PR=(R-RVAL(IRM1))/PR	00008170
	FUNT4=(1.-PS)*(1.-PR)*TABL(ISM1,ISM1)+PS*(1.-PR)*TABL(IRM1,IS)	00008180
	FUNT4=FUNT4+PR*(1.-PS)*TABL(IR,ISM1)+PS*PR*TABL(IS,IR)	00008190
	RETURN	00008200
C		00008210
	1000 WRITE(6,6000) S	00008220
	STOP	00008230
	2000 WRITE(6,6005) R	00008240
	STOP	00008250
C		00008260
	6000 FORMAT(1HC,'FUNT4: S = ',1PF12.3,' IS OUT OF RANGE')	00008270
	6005 FORMAT(1HG,'FUNT4: R/B= ',1PF12.3,' IS OUT OF RANGE')	00008280
	END	00008290

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FUNCTION FUNT5(R,S)	00008300
C	00008310
DIMENSION SVAL(11),RVAL(11),TABL(11,11)	00008320
C	00008330
DATA SVAL /1.01,1.02,1.05,1.07,1.1,1.15,1.2,1.3,1.5,2.,3./	00008340
DATA RVAL / .02,.04,.06,.08,.1,.12,.14,.18,.22,.26,.3/	00008350
DATA TABL /1.75,3.,4.,4.5,5.,6.,7.,8.,8.5,9.,9.,	00008360
1 1.2,1.75,2.8,3.5,4.,4.3,4.7,5.,6.,6.5,7.,	00008370
2 .95,1.38,1.85,2.,3.,3.3,3.6,4.,4.5,4.75,5.,	00008380
3 .87,1.25,1.63,2.,2.7,3.1,3.5,4.,4.4,4.7,5.,	00008390
4 .82,1.12,1.5,1.87,2.3,3.,3.5,4.,4.5,4.75,5.,	00008400
5 .75,1.15,1.5,2.,2.6,4.4,5.,6.5,7.5,8.5,9.5,	00008410
6 .7,1.15,1.45,1.85,2.25,5.,6.3,7.5,8.5,8.5,9.5,	00008420
7 .55,1.1,1.42,1.84,3.3,5.,6.,7.5,8.5,9.5,10.,	00008430
8 .44,1.35,2.,3.5,4.4,5.,6.,8.,9.,10.,11.,	00008440
9 .36,1.7,5.,5.,6.,6.5,7.,9.,10.,11.,12.,	00008450
A .18,3.,5.,7.,8.,9.,10.,11.,12.,12.,12./	00008460
C	00008470
IF (S.GT.SVAL(11)) GO TO 1000	00008480
IF (R.GT.RVAL(11)) GO TO 2000	00008490
IF (S.GE.SVAL(1)) GO TO 5	00008500
S=1.01	00008510
5 IF (R.GE.RVAL(1)) GO TO 6	00008520
R=.02	00008530
6 CONTINUE	00008540
C	00008550
DO 10 IS=2,11	00008560
IF (S.LT.SVAL(IS)) GO TO 20	00008570
10 CONTINUE	00008580
IS=11	00008590
20 DO 30 IR=2,11	00008600
IF (R.LT.RVAL(IR)) GO TO 40	00008610
30 CONTINUE	00008620
IR=11	00008630
40 ISM1=IS-1	00008640
IRM1=IR-1	00008650
PS=SVAL(IS)-SVAL(ISM1)	00008660
PS=(S-SVAL(ISM1))/PS	00008670
PR=RVAL(IR)-RVAL(IRM1)	00008680
PR=(R-RVAL(IRM1))/PR	00008690
FUNT5=(1.-PS)*(1.-PR)*TABL(IRM1,ISM1)+PS*(1.-PR)*TABL(IRM1,IS)	00008700
FUNT5=FUNT5+PR*(1.-PS)*TABL(IR,ISM1)+PS*PR*TABL(IS,IR)	00008710
RETURN	00008720
C	00008730
1000 WRITE(6,6000) S	00008740
STOP	00008750
2000 WRITE(6,6005) R	00008760
STOP	00008770
C	00008780
6000 FORMAT(1H0,'FUNT5: W/H = ',1PE12.3,' IS OUT OF RANGE')	00008790
6005 FORMAT(1H0,'FUNT5: RAD/H= ',1PE12.3,' IS OUT OF RANGE')	00008800
END	00008810



```

PROGRAM SCPLCT(INPUT,OUTPUT,TAPE8=INPUT,TAPE5=INPUT,
*           TAPE6=OUTPUT,PLOT)

```

```

C   THIS ROUTINE GENERATE PLOTS ON AN SC4020 FROM A PREVIOUSL

```

```

C   GENERATED DATA FILE

```

```

C

```

```

C

```

```

C

```

```

C

```

```

CONSTANTS AND DATA DECLARATIONS

```

```

INTEGER CDTITL,CDDATA,CDDEND,CDHDR1,CDHDR2,CDHDR3,CDHDR4

```

```

INTEGER CDHDR5,CDHDR6,Y1SYMB,Y2SYMB

```

```

INTEGER TITLE(6),FHDRS(8,6)

```

```

C

```

```

INTEGER TITLE(9),FHDRS(13,6)

```

```

INTEGER CDTYPE,NDPTS,NPLOTS,NLABLS,MXDPTS,CAMRAS,ADARY(4)

```

```

INTEGER NPLOTS,LPRFLG,RX1,RX2,RX3,RX4,RY1,RY2,RY3,RY4

```

```

INTEGER B1,B2,RM1

```

```

C

```

```

C

```

```

MAX OF 200 DATA POINTS

```

```

C

```

```

REAL XVAL(201),Y1VAL(201),Y2VAL(201)

```

```

REAL XMAX,YMAX,XMIN,YMIN

```

```

REAL XMAXIN,YMAXIN,XMININ,YMININ

```

```

REAL XINCIN,YINCIN,XINC,YINC

```

```

REAL CYPBLK,X1,X2,Y1,Y2

```

```

REAL XB1,XB2

```

```

REAL YMXIST(4)

```

```

DATA CDTITL/4HTITL/

```

```

DATA CDDATA/4HDATA/

```

```

DATA CDDEND/4HHDRS/

```

```

DATA CDHDR1/4HHDR1/

```

```

DATA CDHDR2/4HHDR2/

```

```

DATA CDHDR3/4HHDR3/

```

```

DATA CDHDR4/4HHDR4/

```

```

DATA CDHDR5/4HHDR5/

```

```

DATA CDHDR6/4HHDR6/

```

```

DATA Y1SYMB/1HX/

```

```

DATA Y2SYMB/1HQ/

```

```

DATA MXDPTS/200/

```

```

DATA YMXIST/.1,.5,.1,.5./

```

```

C

```

```

C

```

```

C

```

```

INITIALIZE

```

```

XMIN = 0.

```

```

YMIN = 0.

```

```

NPLOTS = 1

```

```

C

```

```

C

```

```

C

```

```

READ PARAMETER CARD

```

```

READ (5,100) XMAXIN,YMAXIN,XINCIN,YINCIN,CAMRAS,

```

```

*           ADARY

```

```

1000 FOR AT (4F11.4,14.4A6)

```

```

C

```

```

C

```

```

PRINT INPUT SPECIFICATIONS

```

```

C

```

```

WHILE (6,20.0)

```

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```

2000 FORMAT (/# INPUT SPECIFICATIONS#/)
      WRITE (6,2010) XMAXIN,YMAXIN,XINCIN,YINCIN,CAMRAS,
      *              ADARY
60    2010 FORMAT (# MAXIMUM X           = #, 1PE10.3/
      *           # MAXIMUM Y           = #, 1PE10.3/
      *           # INCREMENT X          = #, 1PE10.3/
      *           # INCREMENT Y          = #, 1PE10.3/
      *           # CAMRAS                = #, I3/
      *           # SPECIAL INSTRUCTIONS = #, 4A6////)

65    C
      C      DEFAULT SETTINGS IF NOT INPUT
      C
      IF (CAMRAS .LE. 0) CAMRAS = 35

70    C
      C      START PLOT
      C
      CALL IDENT (CAMRAS,ADARY)
      C
      C      INITIAL READ
75    C
      C      READ (8,1010,END=999) CDTYPE,TITLE,CYPBLK
      C      READ (8,1010) CDTYPE,TITLE,CYPBLK
      C      IF (EOF(8)) 999,35

80    C
      C      MAIN PGM LOGIC
      C
      CALL PRINTV (-20,20HAAAAAAAAAAAAAAAAAAAAAAAA,300,100)
      CALL PRINTV (-20,20HBBBBBBBBBBBBBBBBBBBBBBBB,280,100)
      CALL PRINTV (-20,20HCCCCCCCCCCCCCCCCCCCCCCCC,260,100)
85    CALL PRINTV (-20,20HDDDDDDDDDDDDDDDDDDDDDDDD,240,100)
      CALL PRINTV (-20,20HEEEEEEEEEEEEEEEEEEEEEEEE,220,100)
      CALL PRINTV (-20,20HFFFFFFFFFFFFFFFFFFFFFFFF,200,100)
      CALL FRAMEV(3)
90    30 CONTINUE
      NPLOTS = NPLOTS + 1

      C
      C      INPUT DATA FOR A PLOT
      C
      C      READ (8,1010,END=999) CDTYPE,TITLE,CYPBLK
95    C      READ (8,1010) CDTYPE,TITLE,CYPBLK
      C      IF (EOF(8)) 999,32
      1010 FORMAT (A4,4X,5A10,A4,9X,E9.0)
      C1010 FORMAT (A4,4X,9A6,9X,E9.0)
      32 CONTINUE

100   C
      C      ADVANCE FRAME FOR NEXT PLOT
      C
      CALL FRAMEV(3)
105   35 CONTINUE

      C
      C      IF NOT TITLE CARD - SEQ ERROR
      C
      IF (CDTYPE .NE. CDTITLE) GO TO 970
      NPLOTS = 0
      XMAX = 0.
110

```



```

      YMAX = 0.
C
C      MAIN DATA READ LOOP
C
115      50 CONTINUE
      NDPTS = NDPTS + 1
      READ (8,1020) CDTYPE,Y1VAL(NDPTS),Y2VAL(NDPTS),XVAL(NDPTS)
1020  FORMAT (A4,3E12.3)
C
120      C      CHECK FOR END OF DATA VALUES
C
C      IF (CDTYPE .EQ. CDDEND) GO TO 100
C
C      ERROR IF NOT DATA CARD
125      C
C      IF (CDTYPE .NE. CDDATA) GO TO 980
C
C      ERROR IF MAX DATA POINTS EXCEEDED
C
130      C      IF (NDPTS .GT. MXDPTS) GO TO 975
C
C      ACCUMULATE MAX DATA VALUES
C
      XMAX = AMAX1(XMAX,XVAL(NDPTS))
135      YMAX = AMAX1(YMAX,Y1VAL(NDPTS),Y2VAL(NDPTS))
      GO TO 50
100  CONTINUE
C
C      ADJUST NUMBER OF DATA POINTS COUNTER
140      C
C      NDPTS = NDPTS - 1
C
C      READ HEADER CARDS
C
145      READ (8,1030) CDTYPE,(FHDRS(I,1),I = 1,8)
1030  FORMAT (A4,7A10,A6)
C1030  FORMAT (A4,12A6,A2)
      IF (CDTYPE .NE. CDHDR1) GO TO 985
      READ (8,1030) CDTYPE,(FHDRS(I,2),I = 1,8)
150      IF (CDTYPE .NE. CDHDR2) GO TO 985
      READ (8,1030) CDTYPE,(FHDRS(I,3),I = 1,8)
      IF (CDTYPE .NE. CDHDR3) GO TO 985
      READ (8,1030) CDTYPE,(FHDRS(I,4),I = 1,8)
      IF (CDTYPE .NE. CDHDR4) GO TO 985
155      READ (8,1030) CDTYPE,(FHDRS(I,5),I = 1,8)
      IF (CDTYPE .NE. CDHDR5) GO TO 985
      READ (8,1030) CDTYPE,(FHDRS(I,6),I = 1,8)
      IF (CDTYPE .NE. CDHDR6) GO TO 985
C
160      C      SET UP PARAMS FOR THIS GRAPH
C
C      IF INPUT MAXS LT CALCULATED MAXS - INPUTS ARE OVERRIDDEN
C
165      150 CONTINUE
      IF (XMAXIN .GE. XMAX) GO TO 158

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```

      I = 0
C
C      ADJUST XMAX
C
170      152 CONTINUE
      I = I + 1
      IF (I .GT. 100) GO TO 965
      IF (10**I .LT. XMAX) GO TO 152
      XMAX = 10**I
175      GO TO 160
      158 CONTINUE
      XMAX = XMAXIN
160      CONTINUE
      IF (YMAXIN .GE. YMAX) GO TO 168
180      C
      C      ADJUST YMAX
      C
      DO 162 I = 1,4
      IF (YMXST(I) .LT. YMAX) GO TO 162
185      YMAX = YMXST(I)
      GO TO 170
      162 CONTINUE
      I = 0
164      CONTINUE
190      I = I + 1
      IF (I .GT. 100) GO TO 965
      IF (10**I .LT. YMAX) GO TO 164
      YMAX = 10**I
      GO TO 170
195      168 CONTINUE
      YMAX = YMAXIN
C
C      COMPUTE INCREMENTS
C
200      170 CONTINUE
C
C      CALCULATE X INCREMENT IF NOT SPECIFIED
C
      IF (XINCIN .GT. 0.) GO TO 175
205      172 CONTINUE
      XINC = XMAX / 10.
      GO TO 180
C
C      IF SPECIFIED INCREMENT WOULD ALLOW MORE THAN 10 TIC MARKS
C      OVEPRIDE
210      C
      175 CONTINUE
      IF (XMAX/XINCIN .GT. 10.) GO TO 172
      XINC = XINCIN
215      C
      C      CALCULATE Y INCREMENT IF NOT SPECIFIED
      C
      180 CONTINUE
      IF (YINCIN .GT. 0.) GO TO 185
220      182 CONTINUE

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      YINC = YMAX / 10.
      GO TO 190
C
C      IF SPECIFIED INCREMENT WOULD ALLOW MORE THAN 10 TIC MARKS
225 C      OVERIDE
C
      185 CONTINUE
      IF (YMAX/YINCIN .GT. 10.) GO TO 182
C
230 C      OUTPUT CALCULATED SPECIFICATIONS
C
      190 CONTINUE
      WRITE (6,2020) NPLOTS,NDPTS,XMAX,YMAX,XINC,YINC,CYPBLK
2020 FORMAT (//# SPECIFICATIONS FOR PLOT #,I3//
235 C      # NUMBER OF DATA PTS = #, I3/
C      # MAXIMUM X = #, IPE10.3/
C      # MAXIMUM Y = #, IPE10.3/
C      # INCREMENT X = #, IPE10.3/
C      # INCREMENT Y = #, IPE10.3/
240 C      # CYCLES PER BLOCK = #, IPE10.3)
C
C      DEFINE AND SET SCALING FACTORS FOR PLOTTING AREA
C
      200 CONTINUE
245 C      CALL XSCALV (XMIN,XMAX,150.50)
C      CALL YSCALV (YMIN,YMAX,150.50)
C
C      DRAW SQUARE SURROUNDING PLOT AREA
C
250 C      220 CONTINUE
C
C      GET RASTER COORDS OF ENDPOINTS
C
C      CALL XSCLV1 (XMIN,RX1,ERRFLG)
255 C      CALL XSCLV1 (XMAX,RX2,ERRFLG)
C      CALL YSCLV1 (YMIN,RY1,ERRFLG)
C      CALL YSCLV1 (YMAX,RY2,ERRFLG)
C
      RX1 = IXV(XMIN)
      RX2 = IXV(XMAX)
260 C      RY1 = IYV(YMIN)
C      RY2 = IYV(YMAX)
C
C      DRAW SQUARE
C
265 C      CALL XAXSTP (RX1,RY1,RX2)
C      CALL YAXSTP (RX2,RY1,RY2)
C      CALL XAXSTP (RX2,RY2,RX1)
C      CALL YAXSTP (RX1,RY2,RY1)
C      CALL XAXISV (RX1,RY1,RX2)
270 C      CALL YAXISV (RX2,RY1,RY2)
C      CALL XAXISV (RX2,RY2,RX1)
C      CALL YAXISV (RX1,RY2,RY1)
C
C      DRAW TITLE (ASSUME CENTERED ON INPUT)
275 C

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ORIGINAL PAGE IS  
POOR QUALITY



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      CALL RITE2V (56,13,1023,90,1.54,1,TITLE,ERRFLG)
C
C      DRAW AXIS TITLES
C
280      CALL PRINTV (-6,6HCYCLES,RX1+390,RY1-40)
      CALL PRINTV (-6,6HBLOCKS,RX1+390,RY2+43)
      CALL APRNTV (0,-14,-6,6INCHES,RX1-125,RY1+454)
C
C      DRAW INFO LINES
C
285      SET UP TO DRAW INFO LINES ABOVE OR BELOW CENTER
      DEPENDING ON INITIAL VALUES OF DATA
C
290      RY3 = 950
      IF ( (Y2VAL(1) + Y1VAL(1)) / 2. .GT. YMAX / 2. ) RY3 = 295
      DO 260 I = 1,6
      CALL PRINTV (76,FHDRS(1,I),RX1+16,RY3)
      RY3 = RY3 - 15
295      260 CONTINUE
C
C      DRAW SYMBOL LEGEND
C
      RY3 = RY3 - 10
300      CALL PRINTV (-13,13HSYMBOLS: A = ,RX1+16,RY3)
      CALL PRINTV (1,Y1SYMB,RX1+124,RY3)
      RY3 = RY3 - 15
      CALL PRINTV (-13,13H          C = ,RX1+16,RY3)
      CALL PRINTV (1,Y2SYMB,RX1+124,RY3)
C
305      GENERATE TIC MARKS AND LABELS
C
C      LABEL AND TIC MARK ORIGIN (0,0)
C
310      CALL LINE2V (RX1-4,RY1+8,0)
      CALL LINE2V (RX1,RY1-4,0,8)
      CALL PRINTV (-1,1H0,RX1,RY1-16)
      CALL PRINTV (-1,1H0,RX1-16,RY1)
C
315      DRAW X AXIS LABELS
C
      X1 = XMIN
      NLABLS = XMAX / XINC - .99
320      DO 340 I = 1,NLABLS
C
C      GET NEXT TIC MARK VALUE
C
      X1 = X1 + XINC
325      CALL XSCLV1 (X1,RX3,ERRFLG)
      RX3 = IXV(X1)
C
C      DRAW TIC MARK
C
330      CALL LINE2V (RX3,RY1-4,0,8)

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C
C   LABEL TIC MARK
C
C   CALL LABLV (X1,RX3-35,RY1-18,-2,1,1)
335 C
C   COMPUTE BLOCK LABEL VALUE
C
C   B1 = X1 / CYPBLK
C   B2 = B1 + 1
340 C   XB1 = B1 * CYPBLK
C   XB2 = B2 * CYPBLK
C
C   GET VALUE CLOSEST TO CYCLE TIC MARK
C
C   IF ( ABS(XB2-X1) .GT. ABS(X1-XB1) ) GO TO 320
C   XB1 = XB2
C   B1 = B2
345 C   320 CONTINUE
C
C   IF MORE THAN ONE HALF A CYCLE TIC MARK AWAY DON'T DRAW
C
C   IF (XB1 .GT. X1 + XINC/2. .OR. XB1 .LT. X1 - XINC/2.) GO
C
C   GET RASTER COORDS
355 C
C   CALL XSCLV1 (XB1,RB1,ERRFLG)
C   RB1 = IXV(XB1)
C
C   DRAW TIC MARK
360 C
C   CALL LINE2V (RB1,RY2-4,0,8)
C
C   LABEL TIC MARK
C
365 C   XB1 = B1
C   CALL LABLV (XB1,RB1-35,RY2+12,-2,1,1)
C   340 CONTINUE
C
C   LAST TIC MARK AT XMAX (UNLESS UNUSUAL USER INCREMENT
370 C   SPECIFIED)
C
C   CALL XSCLV1 (X1+XINC,RX3,ERRFLG)
C   RX3 = IXV(X1+XINC)
C   IF (IABS(RX3-RX2) .GE. 5) GO TO 360
375 C   CALL LINE2V (RX2,RY1-4,0,8)
C   CALL LABLV (XMAX,RX2-35,RY1-18,-2,1,1)
C
C   DRAW LAST BLOCK LABEL IF IN PLOT AREA
380 C
C
C   COMPUTE BLOCK LABEL VALUE
C
C   B1 = XMAX / CYPBLK
C   XB1 = B1 * CYPBLK
385 C

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C      IF MORE THAN ONE HALF A CYCLE TIC MARK AWAY DON'T DRAW
C
C      IF (XB1 .LT. XMAX - XINC/2.) GO TO 360
C
390    C      GET RASTER COORDS
C
C      CALL XSCLV1 (XB1,RB1,ERRFLG)
C      RB1 = IXV(XB1)
C      CALL LINE2V (RB1,RY2-4,0,8)
395    C      XR1 = B1
C      CALL LABLV (XB1,RB1-35,RY2+12,-2,1,1)
C
C      DRAW Y AXIS LABELS
C
400    C      360 CONTINUE
C      Y1 = YMIN
C      NLABLS = YMAX / YINC - .99
C      DO 380 I = 1,NLABLS
C      Y1 = Y1 + YINC
405    C      CALL YSCLV1 (Y1,RY3,ERRFLG)
C      RY3 = IYV(Y1)
C
C      DRAW TIC MARK
C
410    C      CALL LINE2V (RX1-4,RY3,8,0)
C
C      LABEL TIC MARK
C
C      CALL LABLV (Y1,RX1-92,RY3,-3,1,1)
415    C      380 CONTINUE
C
C      LAST TIC MARK AT YMAX (UNLESS UNUSUAL USER INCREMENT
C      SPECIFIED
C
C
420    C      CALL YSCLV1 (Y1+YINC,RY3,ERRFLG)
C      RY3 = IYV(Y1+YINC)
C      IF (IABS(RY3-RY2) .GE. 5) GO TO 400
C      CALL LINE2V (RX1-4,RY2,8,0)
C      CALL LABLV (YMAX,RX1-92,RY2,-3,1,1)
425    C
C      C      PLOT DATA
C
C      400 CONTINUE
C      CALL XSCLV1 (XVAL(1),RX3,ERRFLG)
430    C      CALL YSCLV1 (Y1VAL(1),RY3,ERRFLG)
C      CALL YSCLV1 (Y2VAL(1),RY4,ERRFLG)
C      RX3 = IXV(XVAL(1))
C      RY3 = IYV(Y1VAL(1))
C      RY4 = IYV(Y2VAL(1))
435    C
C      C      PLOT SYMBOL AT FIRST DATA POINT (BOTH Y VALUES)
C
C      CALL PLOTV (RX3,RY3,Y1SYMB)
C      CALL PLOTV (RX3,RY4,Y2SYMB)
440    C      CALL PLOTV (RX3,RY3,20)

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C      CALL PLOTV (RX3,RY4,29)
C      IF (NDPTS .LE. 1) GO TO 431
C
C      LOOP FOR REST OF DATA POINTS
445  C
C      DO 430 I = 2,NDPTS
C
C      GET COORDS OF NEXT POINT
C
450  C      CALL XSCLV1 (XVAL(I),RX1,ERRFLG)
C      CALL YSCLV1 (Y1VAL(I),RY1,ERRFLG)
C      CALL YSCLV1 (Y2VAL(I),RY2,ERRFLG)
C      RX1 = IXV(XVAL(I))
C      RY1 = IYV(Y1VAL(I))
455  C      RY2 = IYV(Y2VAL(I))
C
C      PLOT SYMBOL AT DATA POINT (FOR BOTH Y VALUES)
C
C      CALL PLOTV (RX1,RY1,Y1SYMB)
460  C      CALL PLOTV (RX1,RY2,Y2SYMB)
C      CALL PLOTV (RX1,RY1,20)
C      CALL PLOTV (RX1,RY2,29)
C
C      DRAW LINE FROM PREVIOUS POINT TO THIS POINT
465  C
C      CALL LINEV(RX3,RY3,RX1,RY1)
C      CALL LINEV (RX3,RY4,RX1,RY2)
C
C      SET UP FOR NEXT POINT
470  C
C      RX3 = RX1
C      RY3 = RY1
C      RY4 = RY2
C      430 CONTINUE
475  C      431 CONTINUE
C
C      GO TO NEXT PLOT
C
C      GO TO 30
480  C
C      MAX OF 10**100 EXCEEDED
C
C      965 CONTINUE
C      WRITE (6,2990)
485  C      2990 FORMAT (/# MAX VALUE OF 10**100 EXCEEDED#)
C      GO TO 995
C
C      FIRST CARD IN DATA GROUP NOT A TITLE CARD
C
490  C      970 CONTINUE
C      WRITE (6,3000)
C      3000 FORMAT (/# MISSING TITLE CARD - DATA SEQUENCE ERROR#)
C      GO TO 995
C
495  C      MAX DATA POINTS EXCEEDED

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C
  975 CONTINUE
      WRITE (6,3010) MXDPTS
500  3010 FORMAT (/1X,I4,*, DATA POINT MAXIMUM EXCEEDED*)
      GO TO 995
C
C    DATA CARD EXPECTED BUT NOT READ
C
  980 CONTINUE
505  980 CONTINUE
      WRITE (6,3020)
      3020 FORMAT (/*, MISSING EXPECTED DATA CARD - DATA SEQUENCE ERR
      GO TO 995
C
C    HDR CARD MISSING
510  985 CONTINUE
      WRITE (6,3030)
      3030 FORMAT (/*, MISSING HDR CARD - DATA SEQUENCE ERROR*)
      GO TO 995
515  995 CONTINUE
      GENERAL ERROR TERMINATION
C
  995 CONTINUE
      WRITE (6,3040)
520  3090 FORMAT (/*, ***, RUN TERMINATED ***)
C    CALL ENDJOB
      STOP 777
  999 CONTINUE
525  999 CONTINUE
      CALL ENDJOB
      STOP
      END
```